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EDITORIAL.

WITH the single exception of the promised paper on the "Pitch Lake of Trinidad," we have been enabled, with the valued aid of our contributors, to carry out the programme of work which we set before our readers twelve months ago.

Turning to some of the more important projects in our new year's work, we have received the promise of some further Astronomical Plates from Dr. Isaac Roberts, to whom we are already so much indebted for numerous magnificent examples of Astronomical Photography. Mr. E. Walter Maunder is going out to Algeria for the purpose of observing the solar eclipse of May, 1900, and he will relate his experiences in our columns. Mr. Maunder is also at work upon a series of popular articles on "Astronomy without a Telescope," to commence with the January number. In this department of our work we hope to have the aid of Miss Agnes M. Clerke, Mr. J. Evershed, Mr. A. Fowler, Mr. J. E. Gore, and Prof. E. C. Pickering. Mr. W. F. Denning will again contribute a column during the year on Comets and Meteors, and Mr. Fowler will continue to conduct the column on the Face of the Sky.

We hope to publish at an early date an original drawing of the Planet Mars, which has been specially made for KNOWLEDGE by M. Eugene M. Antoniadi, who will also contribute a further paper on "Cloud Photography," to be illustrated by some more of his successful photographs of clouds.

An important series of Ethnological Studies from the facile pen of Mr. R. Lydekker will commence in our January number with a consideration of the native races of the Australian continent. These articles will be fully illustrated from a selection of interesting photographs which Mr. Lydekker has kindly placed at our disposal.

Our readers will be glad to learn that there is considerable prospect of Mr. Fred. Enock's return to our columns as a contributor of those delightful life-histories of minute insects, which have been too long absent from our pages, owing to great press of work upon the author.

Arrangements have also been made for the issue, during the year, of a series of original articles by Mr. H. H. W. Pearson, of the Royal Gardens, Kew, on "Plants and their Food," in which Mr. Pearson proposes to consider in detail the nutrition of the green plant. In addition, we hope to place before our readers several further sets of papers, for which arrangements are now in progress, and of these we may direct attention to the following:—A set of studies on "Scenery and Geology in Europe," by Prof. Grenville A. J. Cole; a series of papers on "Wireless Telegraphy," by Mr. G. W. de Tunzelmann; and an introduction to sociology and to the origins of history, under the title of "The Evolution of Simple Societies," by Prof. Alfred C. Haddon, who proposes to describe the hunters, fishers, herders, and tillers in typical communities, and to note the effects of environment and mode of life upon them.

The Rev. Thomas R. R. Stebbing will contribute two or three concluding chapters to his fascinating study of the *Crustacea*, with which he has delighted our readers during the past two years; Mr. Howard B. Little will contribute some articles on "Electricity as a Natural Force," in which he proposes to deal with thunderstorms, magnetic storms, and the Aurora Borealis; and, finally, Mr. William Shackleton informs us that he is now hoping to redeem his promise of last year in regard to the article on "The Pitch Lake of Trinidad."

We avail ourselves of this opportunity to offer our grateful thanks to our readers, our contributors, and to the Press, for the generous support accorded to our efforts, and our assurance that we intend to spare no labour in making the pages of KNOWLEDGE both useful and welcome all over the world.

XUM

ON THE TREATMENT AND UTILIZATION OF ANTHROPOLOGICAL DATA.

By Arthur Thomson, M.A., M.B.

VI.—FACIAL FORM.

THE skeleton of the face, as one might reasonably expect from a knowledge of the living, displays many characteristic varieties of form. As was pointed out in a previous article,* the shape of the skull is to some extent dependent on the size of the jaws, and the development of the muscles which control the movements of the mandible. It will be obvious that the size of the jaws will be largely determined by the size of the teeth, and as in savage races the teeth are, as a rule, larger than in the more highly civilised peoples, it naturally follows that the architecture of the face will be modified by the massiveness of the jaws and their associated structures. The late Professor Sir William Flower was amongst the first to recognise this fact, and by comparing the length occupied by the upper molars and premolar teeth with the length of the cranio-facial axis (basi-nasal length) he determined the dental index by the following formula :—

$$\frac{\text{Length of 5 molars} \times 100}{\text{Basi-nasal length}} = \text{Dental index.}$$

In this way he was able to group the races of man according to the size of their teeth into three varieties :—

a *b* *c*

Fig. 1.

a *b* *c*

Fig. 2.

Figs. 1 and 2 represent Skulls with large, medium, and small Teeth. *a*, Macrodont; *b*, mesodont; *c*, microdont.

I.—The Microdont, with an index below 42, including mixed Europeans, ancient Egyptians, low-caste natives of India, and Polynesians.

II.—Mesodont, with an index ranging between 42 and 44, comprising Chinese, American Indians, Malays, etc.

III.—Megadont, having an index over 44. This group embraces Melanesians, Andamanese, and the Australian and Tasmanian races.

The reduction in the size of the teeth in the higher races is probably explained by a reference to the more common methods of preparing the food by cooking, etc., which renders unnecessary a powerful masticatory apparatus. On the other hand, the size of the teeth in the lower races is oftentimes much larger than might be at first assumed from a casual inspection of a large number of skulls. This fact was borne out during the discussion which took place on the remarkable fossil remains brought from Java by Dr. Dubois. These included a skull, a thigh bone, and two molar teeth, presumably all belonging to the same individual. We are not at present concerned with the skull or thigh bone, which the discoverer claimed, with much show of truth, belonged to an intermediate form between man and the higher apes, which he distinguished under the name of *Pithecanthropus erectus*, but rather to draw attention to the aspects of the case as determined by the teeth. These were of large size, and, among other points, it was urged that they were too big to be human. This assertion at once put all the anatomists who had large collections under their charge on the "qui vive," and many hundreds of specimens were examined with the object of determining this point. It soon became apparent that this argument against the Trinil teeth being human would have to be abandoned, as a number of instances were forthcoming in which undoubtedly human teeth equalled, if they did not excel, the fossil specimens in size. It would therefore appear extremely hazardous to express any opinion as to the limits of size within which we should regard teeth as human.

The teeth, which are embedded in the alveolar border of the jaw (we are speaking now only of the upper jaw) must, when large, occupy more room, and, necessarily, lead to the expansion of that part of the jaw which supports them; this need not necessarily produce an equal development of the entire bone, though doubtless, involving modifications of form, but will of course cause an expansion or projection of its lower part, comparable to the muzzle seen in many animals. The reader will at once appreciate the form of face dependent on this projection of the jaws if he studies the appearance presented by a typical negro, in whom, however, it is as well to bear in mind that the appearance is much exaggerated by the thickened and everted lips. To this projection of the muzzle attention was directed by a Dutch anatomist named Camper, who was the first to attempt to estimate it by a scientific method. He found that the angle formed by the intersection of two lines, of which one passed across the face, cutting the orifice of the ear posteriorly, and lying on the level with the lower edge of the septum of the nose in front, whilst the other was applied to the profile of the face, resting on the most prominent part of the forehead above and the anterior surface of the upper incisor teeth below, varied considerably, ranging from 62° to 85°, corresponding, in the first instance, with a projecting muzzle and a sloping face, in the latter with a profile more nearly approaching the vertical. On the living, Camper's method of determining the facial angle is still employed by the use of appropriate instruments, but in this country the method suggested by Flower is that more commonly made use of to determine the amount of projection of the upper jaw in the macerated skull. This method depends on the proportions which two measurements bear to one another—the basi-nasal length (*i.e.*, the distance from the anterior edge of the foramen magnum to the fronto-nasal suture) as compared with the

* Knowledge, October, 1899.

basi-alveolar length (*i.e.*, the distance from the anterior margin of the foramen magnum to a point on the alveolar border of the upper jaw between the two central incisors). Regarding the former as the constant, and the latter as the variable, we are in this way enabled to determine the gnathic or alveolar index :—

$$\frac{\text{Basi-alveolar length} \times 100}{\text{Basi-nasal length}} = \text{Gnathic index.}$$

The sub-division of the resulting indices into three groups is, of course, purely arbitrary. Flower classified his results as follows:—When the index falls below 98, it indicates that the jaw projects but slightly. Such crania are termed orthognathous, and include, amongst others, the mixed European races, ancient Egyptians, Veddahs, etc. When the index ranges between 98 and 103, the jaws are more projecting ; this, the mesognathous group, comprises Chinese, mixed Polynesians, American Indians, etc. Whilst, when the index rises above 103, we have a very pronounced projection of the jaws, as indicated by the term prognathous applied to the group. Topinard takes exception to this classification, expressing the opinion that the range of Flower's mesognathous group (98–103) is too wide. He would limit it to indices ranging between 98 and 100 or 101, which would have the advantage of practically confining it to the yellow races, whilst all over 100 or 101 he would regard as prognathous. The reader will at once appreciate what this difference in classification entails, for the French anthropologists are in the habit of describing the Australians as a prognathous race, whilst we in England term them mesognathous, their average gnathic index being 101 (Duckworth). Whilst convenient to employ, it cannot be said that Flower's gnathic index is without objection, since it takes no account of the length of the third side of the triangle, viz., the naso-alveolar measurement, for on the length of this must depend the relative projection of the two sides of the triangle, viz., the basi-nasal and the basi-alveolar lengths.

In no respect is the novice so apt to be misled as in regard to this question of projection of the jaws. In handling and comparing skulls the utmost care must be exercised to place them in such a position that certain definite points all lie in the same horizontal plane. Nothing is easier than to convey an impression of prognathism by tilting forward the face of an orthognathous skull, whilst marked degrees of prognathism may be masked by inclining the face in a vertical direction. In the living this comparison of the face is much more easy. The natural position of the head may be said to be that in which the axes of vision of the two eyes lie in the same horizontal plane. If, therefore, we place the subjects under observation in the military position of "attention," with the heads in an easy position, and the eyes directed toward the horizon, the slope of their faces can be satisfactorily compared. In dealing with skulls we must find some substitute for the visual axis, and that most commonly adopted is to place the crania in such a position that a line passing from a point immediately above the external auditory meatus behind, and the lower orbital margin in front, falls in the horizontal plane. Fig. 3 illustrates this method of comparison. A glance at this figure will enable the reader to satisfy himself that without some such common basis of comparison it would be easy to place the skulls in such positions as to lead to erroneous conclusions.

A comparison of the dental and gnathic indices reveals the fact that prognathism of intermediate and pronounced degree is associated with large teeth, whilst the microdont races all more or less conform to the orthognathous type.

The shape of the nose in the living displays remarkable differences, the long and narrow nose of the European contrasts with the short and broad nose of the Negro,

a *b* *c*

FIG. 3.—Shows the varying degree of projection of the Upper Jaw Skull *a* is prognathous; skull *b* is mesognathous ; skull *c* is orthognathous.

whilst the form of the nose in the Australian displays a very characteristic appearance, it is only necessary to mention those extremes in order to draw attention to the many intermediate varieties. The form of the nose depends on the disposition of the bones and cartilages which support it. At present, we are only concerned with the former. Perhaps no feature of the skull is more valuable in assisting the observer roughly to classify the crania which he is examining than the form of the nasal aperture.

a *b* *c*

FIG. 4.—Shows the three types of Nasal aperture. Skull *a* is leptorhine ; skull *b* is mesorhine ; skull *c* is platyrhine.

A reference to Fig. 4 will enable the reader to appreciate for himself as to the typical forms there represented. Usually described as of pyriform shape, the nasal aperture varies in the relative proportions of its width and height. This is expressed by the nasal index, which is determined by employing the following formula—

$$\frac{\text{Nasal width} \times 100}{\text{Nasal height}} = \text{Nasal index.}$$

The nasal width corresponds to the maximum diameter of the aperture, whilst the nasal height is estimated by the measurement from the nasion (fronto-nasal suture) to the sub-nasal point (middle of inferior edge at base of nasal spine).

The Leptorhine group includes those skulls with a nasal index below 48 ; the Mesorhine between 48 and 53 ; whilst the Platyrhine division comprises those crania with an index above 53. Each of these three groups is typical of the broad divisions of mankind into the white, the yellow, and the black varieties ; thus the white races are leptorhine, that is, they are characterised by a narrow nasal aperture ; the Mongoloid type, if we except the

Esquimaux, possess a nasal aperture of intermediate form, and are hence mesorhine; whilst the black races, including Negroes, Australians, Tasmanians, etc., are platyrhine, and have broad and open nasal apertures.

Here, again, we have an instance of the correlation of certain forms, the platyrhine type of nasal aperture is usually associated with the prognathous or mesognathous form of jaw; the most noticeable exception to this rule being the Bush race, which, although orthognathous, is extremely platyrhine (index 59, Flower).

The relation between the skeletal form of the orbits and the external appearance of the eye, denoting thereby the disposition of the eyelids, and the extent and direction of the palpebral fissure, is not nearly so pronounced as the association between the skeleton of the nose and its external shape. If we except the pronounced projection of the upper orbital margins which is so characteristic of some races, and which imparts to the features an undue projection to the eyebrows and a sunken appearance to the eye, it is doubtful if modifications in the shape of the orbital margins are at all recognisable on the living. We find, however, that in the skull the form of the orbit is subject to many variations. In order to estimate these differences use is made of the orbital index, which expresses the proportionate height of the orbit as contrasted with its width. $\frac{\text{Orbital height} \times 100}{\text{Orbital width}} = \text{Orbital index.}$

When the index falls below 84 the skull is described as Microseme—that is to say, it possesses an orbit of more or less oblong form, the height being much less than the width. When the index is above 89 the aperture is more circular in shape, and the skull displaying this form is called Megaseme.

The intermediate form with indices varying from 84 to 89 belong to the Mesoseme group.

Just as we have seen a correlation between the dental, the gnathic and the nasal indices, so we recognise a like tendency in regard to the orbital index, though not so marked.

This is borne out by an examination of the table prepared by the late Sir W. Flower, and published in the Osteological Catalogue (Man) of the Museum of the College of Surgeons. In no race in which the orbits are megaseme is the skull either prognathous or platyrhine; on the other hand, if we except Guanches and Bushmen, we find microseme skulls displaying both platyrhine and prognathous conditions.

There is some justification therefore for the assumption that, given a human tooth, preferably a molar, we might from a consideration of its size form some general idea of the architecture of the face of the individual to whom it once belonged.

Unfortunately the space at our disposal prevents us for the present from referring to many other points in connection with the disposition and arrangement of the bones of the facial skeleton.

SECRETS OF THE EARTH'S CRUST.

By Grenville A. J. Cole, M.R.I.A., F.G.S., *Professor of Geology in the Royal College of Science for Ireland.*

VI.—THE COMING OF MAN.

MAN presents himself to the calm and enquiring eye of science in so many aspects, in so many fields of enterprise, that it is difficult to deal comprehensively with his career upon the earth, as we might with that of the cockle or the crayfish. He is so near us, even in the Malay or the Negro, that we are apt to place him in a category apart from the rest of animated nature. Even the young science of anthropology, by t very title, confesses that zoology cannot cope unaided with the details daily provided by the aberrant activity of mankind.

The geologist can make no claim to discuss the specific isolation of man, or the origin of his infinite resource. The "god-like apprehension" that gives us on the one hand the dynamite gun, and on the other the Society for the Prevention of Cruelty to Animals, may well stagger a philosopher. Most enquirers are content to retire from this field, observing "there is something in this more than natural, if philosophy could find it out." But the first appearance of man upon the earth, which was formerly regarded as a matter for historians, has become more and more a question of pure geology. Whether the archæologist desires it or no, he has already been forced to take counsel with the stratigrapher in his researches into the earth's crust.

When Sir C. Lyell, in 1863, issued his "Geological Evidences of the Antiquity of Man," a book that ran into three editions in ten months, he took the position that the principles of geology and palæontology must be applied to the solution of the question. He thus observed* that the shell-mounds accumulated by ancient dwellers on the Baltic contain shells of marine species of full growth, whereas those at present living in the adjacent sea have been dwarfed by brackish-water conditions. Or, again, he pointed out (p. 227) the identity of some of the mammalia of the Norfolk Forest-bed with those still contemporary with man, as indicating that we need not "despair of one day meeting with the signs of man's existence in the forest-bed." At that time, the occurrence of man in preglacial epochs was held to be in the highest degree improbable, and archæologists may be found at the present day who look upon Lyell's suggestion as still wild in the extreme.

The remains of man are notably subject to decay, and the signs of his former existence in this or that locality often depend upon the more enduring objects that his skill has left behind. Baked pottery, chipped stone implements, the very charcoal of his fires, may survive in places where his own bones are extremely rare. Much of our knowledge of early man is derived from interments conducted with careful ritual by his tribal fellows. Is it likely that, in a ruder age, when ceremonial burial may have been utterly unknown, the skeleton of man would have much chance of preservation?

Even more robust terrestrial animals may be little known in a fossil state, except in certain fortunate localities. Our acquaintance with the Lower Pliocene or Upper Miocene vertebrate fauna of Europe, to take one example, would be limited, were it not for the local accumulations of skeletons at the farm of Pikermi in Attica, and Mont Luberon in Provence. In neither of these cases is the deposit truly terrestrial; water has brought together the remains, and alluvial mud or gravel has entombed them. At Pikermi, the torrent which swept down the large bones has removed those of the numerous small animals, which must have existed equally on the soil of antique Greece. Hence, even here, the record of the fauna is imperfect.

Unlike many other mammals, early man was not compelled to collect in vast herds around the lakes and watercourses. His very intelligence, his variety of aim, made him a wanderer across the earth. Dying in the forest, or on the barren rock, or isolated in his log-canoe, his skeleton

* "Antiquity of Man," 3rd ed., p. 13.

was rarely covered over and adequately preserved. He was small in comparison with the giant carnivores, with which he competed for his food. Even if he died a natural death, the very fowls of the air could combine to scatter his remains.

Hence, as we work backward, from the present deposits to those of earlier days, the number of human skeletons discoverable decreases with extreme rapidity. Yet there are, up to a certain point, abundant evidences of the occupation of the earth by man. The conclusion is that the earliest types of humanity, without arts, and perhaps without tribal organisation, have probably left very few traces through the strata of the entire crust.

As all interested in the subject are aware, the remains now freely styled "prehistoric" were subjected at one time to the most searching criticism. Had such keenness of attack been directed, let us say, against the assertion that the molluscs of one stratum differed from those found beneath it, William Smith might never have laid the foundations of stratigraphical geology. But the succession of invertebrate life, when Smith was writing in 1815, seemed somewhat remote from human interest; on the other hand, the succession of human remains, in 1847, barely fifty years ago, excited the most lively controversy.* In that year, M. Boucher de Perthes, in his "Antiquités celtiques et antédiluviens," claimed a human origin for his series of chipped flints, found at Abbeville, in association with remains of the mammoth, the rhinoceros, and other mammals extinct in France, or even extinct throughout the world. These flints, from a stratum of ancient river-gravel, are now universally admitted to have been prepared by man, and to be excellent illustrations of the palæolithic stage of his culture in that particular region. If further proof of the association of man and extinct mammalia were wanted, it has been amply supplied by the incised drawing of a mammoth on a curved piece of ivory, found in the cave of La Madeleine, and by the discovery of human bones in the Pampas beds of South America, to mention no other of the pieces of evidence that have accumulated in support of M. de Perthes, the long-suffering pioneer.

It is hard to believe that the pendulum of opinion, as regards the antiquity of man, has now swung round without full reason. It is true that Sir J. W. Dawson, who held that man had existed in Europe for only some six thousand years, wrote, in 1880,† that the antiquity of man "is widely received, owing to the enthusiasm with which novel and startling discoveries, and especially those appearing to contradict old and received opinions, are welcomed at present." If this assertion was made seriously, it shows an amazing ignorance of the history of scientific criticism. In 1880, and down to the present day, archæologists and anthropologists combined to view with the greatest suspicion any new discovery of human remains for which a high antiquity was claimed. Proofs have been, and are, demanded in such cases, more stringent than the stratigraphical geologist is commonly called upon to give. If the coming of man can be clearly shown to have occurred prior to the glacial epoch, this conclusion will have been reached by the running of a blockade, under the search-lights of the scientific world. Again and again the blockade has resisted the attack; again and again the patient worker has had to confess that his evidence was weak and insufficient. It is not the controversialist, however, but the man who can produce his specimens, and who can invite inspection of his diggings, who is likely to succeed in altering the preconceived opinions of our time.

The investigators of the glacial epoch have been, unwittingly, a great bar to the rational treatment of the question. The emphasis laid on the devastation of northern Europe and America by the encroachment of land-ice has made some geologists, at any rate, forget that the "glacial period" or "epoch" is not the parallel of any period or epoch recognised in our stratigraphical nomenclature. Strictly speaking, it is an incident within a geological epoch, and its serious effects were confined to the northern part of the northern hemisphere. In this sense, the inhabitants of Java may assert that they dwell in a volcanic epoch; but life in most parts of the globe is not inconvenienced by the fact. The remains of man in Europe seemed, till recently, to be entirely post-glacial, and consequently the existence of man before the invasion of the ice was held to be highly improbable. But can we believe that man, any more than the mammoth, sprang full-armed from glacial furrows? Are there many who will agree with Sir J. Dawson's assertion* of the "abrupt appearance of man in his full perfection"? This phrase, which classes us with the palæolithic savage, may seem at first uncomplimentary; but perhaps we are asked to infer that the stone age was one of high civilisation. In that case, we shall be all the more inclined to seek farther back for the coming of the earliest man.

It is, however, improbable that we shall find him, or even relics of his race. In the first place, our view must go far beyond Europe, where the deposits of the ice-age have greatly obscured Pliocene terrestrial phenomena. It may also be urged that man originated in warm climates, and never entered Europe until the cold had passed away. Some believe, however, that the human race is an agglomerate of varieties of diverse origin, the present species having resulted from the parallel development of separate stocks, perhaps in separate continents. Such a view, if proved, would complicate the question, and would render the search for the earliest human centre far more difficult than before. In any case, what we now desire to know is the geological epoch of man's appearance and establishment on the earth. To this we can at any rate approximate.

If we listen to those who regard the glacial epoch as limiting the life of the whole globe, it is idle to push our enquiries back even into the Pliocene period. Certain statements, however, have been made from time to time as to the occurrence of Miocene man; and the fate of these has made some workers unduly cautious. The most famous case is that of the Abbé Bourgeois, who found curiously chipped flints in the Lower Miocene of Thenay, near Pont Levoy, in Loir-et-Cher. Figures of these will be found in various works, such as Zittel's "Handbuch der Palæontologie," Band IV., p. 720; but no satisfactory proof can be given of their human origin. It is asserted that the heat of forest-fires can split flint into similar forms; and Zittel compares them with the flakes produced by weathering on the surface of the Libyan desert. Prof. H. W. Haynes† visited Thenay with the Abbé Bourgeois in 1877, and also decides against the acceptance of the flakes, quoting similar occurrences as far back as the Eocene period. Their characters at Thenay, however, are such that some hesitation is allowable. Rather, however, than attribute them to the work of man, most authors will

* *See* the full account in Prof. N. Joly's "Man before Metals" (1883), p. 35.

† "Fossil Men and their Modern Representatives," p. 247.

* *Op. cit.*, p. 246.

† Appendix on Tertiary Man, in G. F. Wright's "Man and the Glacial Period" (1892), p. 370.

accept M. Gaudry's suggestion, supported by Prof. W. Boyd Dawkins,* that, *if artificial*, the flints of Thenay were the work of some intelligent anthropoidal ape. Dryopithecus, which inhabited France in Miocene times, is regarded as an anthropoid of composite type, and was probably about the size of the chimpanzee.† The fact that the apes of the present day, which are specialised along certain ape-like lines, do not chip stones to serve as weapons, in no way militates against the idea that their Miocene ancestors may have done so. The Thenay flints, at any rate, fail to prove the occurrence of Miocene man.

Certain broken flints, found by Ribeiro in the Upper Miocene of Otta, in the Lisbon district, have also been put forward; but they appear to be of doubtful character, when compared with the true flakes of human origin that occur, in the same spot, on the surface of the ground. The remarkable teeth from the Miocene of South Germany, possessing very human characters, are now referred to Dryopithecus, an animal of which the palæontologist has still very much to learn. A more complete series of the apes of Miocene times may come to us some day in the light of a revelation, comparable to that given by the Triassic ammonites, or by the mammals of the Puerco stage.

The soundest argument against the existence of Miocene man is that sustained by Prof. Dawkins, when he indicates the small number of mammalian genera that have come through to us unchanged from Miocene times. Is it likely that a being of such special and delicate organisation as man should be traceable back to a period when the horse, the giraffe, and the elephant, to name no others, were represented by far more generalised forms? As Gaudry points out,‡ the Miocene mammals fully justify the view that the higher types of animal life are more susceptible to variation than the lower. Thus the fresh-water molluscs of Pikermi, found beneath the mammalian layers, are identical with living forms; while the marine molluscs of Cabrières, which are somewhat older than the Luberon deposit, include fifteen species known in existing seas. No mammal at Mt. Luberon, however, is specifically the same as any living form; while many important genera, such as Deinotherium, Machairodus, and Hipparion, have already entirely disappeared. The use made of this argument in limiting the probable antiquity of man is perfectly reasonable and scientific; the true appeal, however, must be made to workers in the field, to observers of the actual crust, as exposed to us in each new section.

A remarkable record of the occurrence of chipped flints was made by Dr. Noetling,§ of the Indian Geological Survey, in 1894. Dr. Noetling's paper had a very modest title, but it was generally agreed that his specimens were of artificial origin. Dr. W. T. Blandford showed‖ that the beds in which the instruments were said to lie were Lower Pliocene rather than Upper Miocene; but this did not diminish the interest of the discovery—on the other hand, its probability was increased. Mr. R. D. Oldham,¶ however, visited the locality with Dr. Noetling, and somewhat briefly recorded his opinion that the flakes had fallen from the surface of an adjacent plateau, and had become mixed with the layer of detritus on the Lower Pliocene bone-bed. The matter might have rested here, despite Mr. Oldham's admission that "ordinarily, there would be no hesitation in ascribing anything found in this layer of loose material to the underlying rock." Mr. Oldham felt that the case could not be decided by ordinary stratigraphical probability. Dr. Noetling, however, replied two years later* by asserting that there was no detrital layer to be dealt with; that chipped flints had been found embedded in the ferruginous conglomerate itself; and that similar flints occurred on the plateau above, but only along the outcrop of the self-same stratum. This implies that, since the implements were made, the stratum has been disturbed by earth movement.

To this unexpected vindication there appears to have been no reply; but, in the meantime, Dr. Dubois published his discovery of the remains of a man-like animal in Java, styled by him *Pithecanthropus erectus*, associated with extinct Pliocene mammals. This discovery, made in 1891, must rank among the greatest palæontological achievements; and, at any rate, it cleared Dr. Noetling from the charge of having rashly put forward an improbable proposition. The characters of the famous skulls of the Neanderthal and of Spy, which had already indicated the existence of a race of men of low cranial capacity, were here, as it were, carried a stage backward. Dr. Dubois,† however, declines to regard the Javan remains as more than anthropoidal; and yet they would indicate an anthropoid, allied to the gibbon, of exceptional zoological position, and probably of exceptional faculties.

If a giant gibbon (Hylobates) were thus endowed with a cranial capacity of 1000 cubic centimetres, *i.e.*, twice that of the existing large anthropoidal apes, it might be something very different in its habits from the long-armed and tree-haunting creature of to-day. Might not such an animal be capable even of chipping flints, or of anticipating in other ways the industries of primæval man?

The introduction of Pithecanthropus into the palæontological series is of the first importance for our present purpose. It probably limits the coming of man to the later Pliocene, or to some subsequent epoch. The arguments of Gaudry and Boyd Dawkins receive fresh justification. Human skeletons must now be sought for, since mere stone implements are liable to various interpretations. It seems probable, however, that Mr. W. J. Lewis Abbott‡ has brought to light, from the Cromer forest-bed, the work of late Pliocene man, and that thus the expectations of Lyell have been fulfilled. The rudely chipped flints, which this observer has discovered and has so carefully discussed, may have been prepared by man in Britain, before the growing ice-age forced him to move further southward. If the human skeletons recorded by Ameghino§ from the Pampas beds of Argentina, as contemporary with the Glyptodon and the Mastodon, are truly Pliocene, they may represent the type of man that produced the Cromer implements. A little further back, such men and Pithecanthropus may have met in serious rivalry; a little further yet, and the pithecanthropoids may have reigned alone, the highest members of creation.

Have we already advanced since Zittel wrote, in 1895,

* "Early Man in Britain" (1880), p. 68.

† *See*, for instance, R. Hartmann, "Anthropoid Apes" (1885), p. 286.

‡ "Les Ancêtres de nos Animaux dans les Temps Géologiques" (1888), p. 211.

§ "On the Occurrence of Chipped (?) Flints in the Upper Miocene of Burmah," *Records Geol. Surv. of India*, Vol. XXVII. (1894), p. 101.

‖ *Nature*, Vol. LI. (1895), p. 608.

¶ *Natural Science*, Vol. VII. (1895), p. 201.

* *Natural Science*, Vol. X. (1897), p. 233.

† "On Pithecanthropus erectus," *Trans. Royal Dublin Soc.*, Vol. VI. (1896), p. 11, &c.

‡ "Worked Flints from the Cromer Forest-Bed," *Natural Science*, Vol. X. (1897), p. 89.

§ *See* Zittel, "Handbuch der Palæontologie," Bd. IV. (1893), p. 718.

"The problem, where man first appeared on the earth and from what form he sprang, has, in spite of all efforts of modern geology and anthropology, up till now found no solution"? If we have indeed advanced, along the lines indicated by the discovery of Dubois, it is but as yet a single step, founded upon a single skeleton. To some thinkers, however, this single step provides a field of vision surpassing all that went before; to others, the coming of man remains, to this day, one of the profoundest secrets of the crust.

THE MYCETOZOA, AND SOME QUESTIONS WHICH THEY SUGGEST.—VII.

By the Right Hon. Sir EDWARD FRY, D.C.L., LL.D., F.R.S., and AGNES FRY.

THEIR RELATIONS IN THE SWARM SPORE STAGE.—Reproduction by *swarm spores* is by no means confined to the myxies. It plays a conspicuous part in the cycle of life in many of the Algæ and Fungi: or rather we should say conspicuous parts, for the functions of these simple pieces of motile protoplasm are most various. Sometimes the swarm spore is asexual and is of itself capable of reproducing a new organism—as in some of the Algæ and in the *Peronosporeæ*, for instance, amongst the Fungi. In some of the Algæ (*Florideæ* and *Phæosporeæ*) the swarm cells are sexual, and a conjugation between two of these moving bodies occurs before the production of a new organism. Sometimes the same organism (as in *Ulva*) produces two kinds of swarm cells—the megaspores with four cilia which germinate asexually, and the microspores with two cilia which germinate only upon conjugation. But more remarkable still is perhaps the case of the well known and beautiful Volvox—which appears to emit no less than four distinct kinds of swarm spores, (1) sterile swarm spores; (2) asexual spores, or as they are called *parthenospores*; (3) male spores; and (4) female spores. So marvellously complicated are the modes in which Nature is capable of differentiating and using to attain the same end by different roads that which seems the simplest thing in life—a minute piece of naked protoplasm.

In the swarm-spore state the myxies may thus seem to claim relationship with the Algæ and Fungi, but it is doubtful whether much stress can be laid on this suggestion, for (1) the existence of these cells as reproductive spores is a wide-spread fact, and occurring in remote groups of organisms, has perhaps but little value in classification; and (2) the mode in which myxies reproduce through swarm spores is entirely different from that pursued by any Alga or Fungus. It is, as we have already shown, neither by parthenogenesis of the ordinary kind, nor by conjugation, but by the fusion of a great number of swarm spores, whether from the same or different sporangia, into a single mass of plasmodium.

But if we turn towards the animal kingdom, we shall find that its claim to include the myxies in the swarm spore stage is very strong.

A mass of naked protoplasm, furnished with a nucleus and vacuoles, capable of pushing forward pseudopodia, and moving by these means, capable of including and digesting food, and also of encystment—this is a description which will fit indifferently the swarm-spore of a myxie and the well-known Amœba, and we are thus brought to see that close relationship, to which we have already referred, between the swarm spores and the large group of protozoa which naturalists generally place in the animal kingdom, and all of which may be said to consist of undifferentiated and naked protoplasm.

THEIR RELATIONS IN THE PLASMODIUM STAGE.—The motor power of the plasmodium seems to recall animal life, but we recollect that there are kindred organisms, like the Diatoms, which are generally regarded as vegetable, and retain a power of movement through life.

As regards food, it is a familiar fact that, generally speaking, plants feed on inorganic and animals on organic substances. So far as observations have hitherto gone, the food of myxies consists of bacteria, or minute particles of wood or fungi (and, in the case of *Badhamia utricularis*, of living fungi). No evidence seems to exist to show that they have any power of deriving nutriment from inorganic substances. The mode in which the myxies eject the undigested matter recalls animal rather than vegetable life. In the methods of digestion, therefore, they seem to lean distinctly towards an animal character.

The movement of the granules of protoplasm in the plasmodium is a phenomenon at least analogous to that found in plants, and even in plants with highly developed cells, but it is not unknown amongst the lower forms which are considered to be animals, for it appears to have been observed in some protista, and especially in the tentacular-like pseudopodia.

In the plasmodium condition, the relationship of the myxies seems on the whole rather with animals than plants.

THEIR RELATIONS IN THE SPORANGIUM STAGE.—On the other hand, when we reach the sporangium stage, the absence of motion, the erect form, the stalk, the foot, the spores, all recall some of the Fungi; the elaters remind us of the Jungermanniæ.

The methods of opening the sporangia, sometimes by an indefinite rupture, sometimes by a distinct operculum, recall the distinction between the methods of opening which prevail in the mosses. On the whole, the facies of the sporangium stage is vegetable.

One other observation which relates to all the stages of development must be made. The two most characteristic of vegetable compounds are probably cellulose and chlorophyll: though neither is found in all plants, nor is absent from some animals. Of chlorophyll we have no trace in the myxies, and of cellulose very little. Nowhere do we find it as the wall of a true and living cell as we do in the most characteristic form of vegetable growth.

THEIR RELATIONS RECONSIDERED.—On the whole it seems impossible to assign these minute organisms with any certainty to the one realm or the other. If, with Hæckel, we were, for purposes of classification, to speak of a new kingdom—a buffer state between the animal and vegetable realms, the *Regnum protisticum*—we should no doubt place the myxies there. But, if we retain the two ancient kingdoms only, then it almost seems as if the myxies were a vagrant tribe that wander sometimes on the one side, and sometimes on the other side of the border line—like nomads wandering across the frontier of two settled and adjoining States, to neither of which they belong. They would seem to begin life as animals and end it as vegetables—a life-history not without some sad analogies in human experience.

The absence of a satisfactory position for the myxies in the great network of organized beings leads one to think of them as a group which probably from very remote antiquity has stood aside from the great currents of evolution, whether in the animal or the vegetable world.

DISTRIBUTION.—The species at present known of myxies are not very numerous. Mr. Lister figures less than two hundred in his monograph; De Bary speaks of them as numbering nearly three hundred. No doubt many species remain to be discovered.

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Of the distribution of the myxies in time, nothing is known. The protoplasm is too delicate to leave its memorial in the rocks, and its lime particles are so small and so indistinguishable that it is no wonder that they have never been traced.

In space, the group, and many individual members of it, are cosmopolitan. A large number of the species are, says Mr. Lister, "found with identically the same characters in Europe, India, the Cape of Good Hope, Australia, and North and South America." What is implied in the identity of a species in Australia and England? Does it mean that the species have passed the great intervening oceans? or does it mean that the species were defined before the separation of the continents, and have continued in both seats unchanged ever since?

Suggestions for Study.—In the hope that some of our readers may be induced by what we have written to take up the study of these little organisms, we will say a few words as to how to begin the study of them. They may be found often in great abundance, and more or less in all times of the year, except in extreme cold or prolonged drought, on moist dead wood and dead leaves (hazel, holly, and beech leaves are very good); a wood yard near a country house, rotting stumps of trees, the dead stalks of last year's nettles, the wooden pillars and parts of gates and rails, the straw heaps in a farmyard—all these are likely places for the chase. Sometimes, too, as we have said, they leave the dead substances, which are their chief habitat, and climb over growing plants, as nettles, periwinkles, or moss. The eye wants some training to see them quickly, and there is no doubt but that young eyes are better than old ones. We know a case in which a young lady detected a Trichia growing on the roadside from her pony's back.

If it be desired to keep specimens for use, they should be preserved in dry boxes (the common lucifer match boxes, lined with white paper, make very good receptacles), into which they can be securely fixed by glue or pins attached to the wood or leaves on which they rest. For more minute observations recourse must, of course, be had to the pocket lens and the microscope. There are few more beautiful objects than some of the sporangia under a low power, or than the capillitium and spores of some kinds under a higher power: the *Trichia* with lemon-coloured hairs and spores are especially lovely to look upon. The spores should be examined under water to prevent shrinkage, and a little spirit is often useful in the examination of the capillitium, as it helps to expel the air.

The beginner will very likely at first sight mistake some of the small fungi for myxies, but a very little experience will enable him to distinguish the sporangium walls, the hairs, and the spores of a myxie from anything which he will meet with in the structure of a fungus.

A visit to the botanical department of the British Museum at South Kensington, and an examination of the microscopic slides and drawings prepared by Mr. Arthur Lister and his daughter, Miss Gulielma Lister, and presented by them to the British Museum, will be of great utility to the student.

To Mr. and Miss Lister all students of myxies are under the deepest obligations, and we are especially so by reason of their constant help, and not least for their kindness in reading this essay in manuscript. Mr. Lister has published two books which are indispensable to the English student. The "Guide to the British Mycetozoa exhibited in the Department of Botany, British Museum," is a little pamphlet, price threepence, written by Mr. Lister for the Trustees of the British Museum, and published by them. It can be obtained at the South Kensington Museum; but booksellers are often stupid about getting it, as we believe that they get no profit on it, and therefore if ordered through a bookseller particular instructions should be given to get it from the South Kensington Museum. This little book is very admirable, and by itself will enable a student to identify most or all of his specimens. Mr. Lister's other book, "A Monograph of the Mycetozoa," which is not confined to British species, was also published by the Trustees of the British Museum, but is sold by Longmans and other booksellers. The price of this book, which is beautifully illustrated, is sixteen shillings. Mr. Massee has also published a "Monograph of the Myxogastres," 1892, illustrated with coloured plates. De Bary's "Comparative Morphology and Fungi, Mycetozoa, and Bacteria," of which an English translation has been published by the Clarendon Press, should be consulted by the student who desires further knowledge. The text-books on general botany and on general cryptogamic botany, such as Sach's Text Book, Kerner's "Natural History of Plants," Bennett and Murray's "Cryptogamic Botany," and Dr. Scott's "Structural Botany, Part II.," may all usefully be consulted.

For the student who desires to go further into the literature of the subject, the following bibliography may prove useful:—

Cienkowski.—*Zur Entwicklungs-geschichte der Myxomyceten.* (*Prings. Jahr.*, 1863, 325); *Das Plasmodium, id.*, 400.

Lister.—"Notes of the Plasmodium of *Badhamia utricularis* and *Brefeldia maxima*" (*Annals of Botany*, Vol. II., 1888, pp. 1-24); "Notes on *Chondrioderma difforme* and other Mycetozoa" (*ibid.*, Vol. IV., 1890, pp. 281-298); "Notes on the Ingestion of Food-material by the Swarm-cells of Mycetozoa" (*Journ. Linn. Soc.*, Vol. XXV., Bot., 1890, pp. 435-441); "Notes on Mycetozoa" (*Journ. of Bot.*, Vol. XXIX., 1891, pp. 257-268); On the Division of the Nuclei in the Mycetozoa" (*Journ. Linn. Soc.*, Vol. XXIX., Bot., 1893, pp. 529-542); "Notes on British Mycetozoa" (*Journ. Bot.*, Vol. XXXIII., 1895, pp. 323-325); "A New Variety of *Enteridium olivaceum*" (*ibid.*, Vol. XXXIV., 1896, pp. 210-212); "On Some Rare Species of Mycetozoa" (*ibid.*, Vol. XXXV., 1897, pp. 209-218); "Notes on Mycetozoa" (*ibid.*, Vol. XXXVII., 1899, pp. 145-152.

Brefeld.—*Dictyostelium mucoroides Abhand. der Senckb., Ges.* VII., 1869; *Untersuchungen aus den Gesammtgebiete der Mykologie*, VI. Heft *Myxomyceten* (Leip., 1884).

De Bary.—*Die Mycetozoen. Zeitsch., fur Wissench Zool.* (Vol. X., 1860, p. 88).

Famintzin and Woronin.—*Über Ceratium Hydnoides* (*Mem. Acad. Peter.*, Vol. XX., No. 3, 1873).

Van Tieghem.—*Sur quelques Myxomycetes* (*Bull. Soc. Bot. Fr.*, Vol. XXVII., 1880, p. 317).

Wigand.—*Zur Morphologie und Systematik der Gattungen Trichia und Arcyria* (*Pring. Jahrb. Bot.*, 1863, p. 1).

TWO MONTHS ON THE GUADALQUIVER.

By Harry F. Witherby, F.Z.S., M.B.O.U.

V.—FLOWERY PLAINS AND BUSTARDS.

LIST OF BIRDS.

MUCH has been written concerning the great bustard, but I cannot conclude these articles without a brief reference to this noble bird, once so common on our own downs and plains. In the south of Spain the great bustard is still abundant, and is always likely to remain so. We made two or three short expeditions in search of these birds

and were always fortunate in seeing them, but only on one occasion were we lucky enough to bring one to bag.

The country by the river, just below Seville, is admirably suited to the habits of the bustard. The land here is a level plain, like the true *marismas* which lie further down the river, but unlike the barren *marismas*, the soil of this land is fertile and produces luxuriant crops of grass and corn. The grass and corn, besides providing them with ample food, form admirable cover for the great bustards when they most need it—in the breeding season.

To this country, then, we devoted a day in the hope of seeing this, the noblest of game birds, at close quarters; but to get to close quarters was no easy task. The stalking horse, our deadliest weapon in the *marismas*, was of no avail, and other methods had to be used. Our men rode the horses, while we walked behind them. We passed through enormous expanses—one cannot call them fields—of pasturage, with great patches of white and yellow flowers blazing and dazzling in the brilliant sun. Just as we were nearing a vast stretch of corn, one of our men stopped his horse, and shading his keen eyes from the glare, exclaimed, *abutarda*—bustard. He pointed, and we stared, but it was some time before we could make out a group of bustards. When we had once made them out, they appeared so big and brown in the grass, that we wondered why we had not seen them before. A careful scrutiny through the binoculars revealed a band of eight—some squatting and only visible when they raised their heads, some standing sleepily, and some pecking at the ground here and there in a desultory fashion. We watched the birds some time, and then, after a careful study of the surrounding land and a brief council of war, we all turned off to the right. The bustard pays little attention to a man on horseback, and will often allow him to approach within two or three hundred yards, but a man on foot is no sooner seen than avoided. We accordingly kept well hidden behind the horses until we had put some high corn between us and the birds. Here our men left us, and while we lay hidden behind the corn, some hundred yards apart, they galloped round in a wide circuit with the object of getting behind the bustards and driving them over us. Crouched behind the corn we waited, but waited in vain, no bustards appeared. At last one of the men rode up saying that the birds had made off to our right before they could get round them. Luckily they did not fly far, and we soon found them again. The same tactics were resorted to, but were again a failure, and worse still the birds flew so far that we failed to mark them down. Indeed it is no easy matter to drive such wary birds and powerful flyers to a definite point on an immense plain.

We went on again, and at length found four other bustards in a more advantageous position for a drive. We hid in a deep ditch, and had the advantage of being able to keep the birds in view the whole time. Our men took a wide circuit, and getting well behind the bustards, closed up quickly. The birds seemed to be very drowsy as they squatted or walked about, but suddenly their heads went up, and as they saw the horsemen advancing they ran a few yards, and then quickly got on the wing. They had looked brown before, but directly they opened their wings, a whitish patch caught the eye, and as they came on with heads outstretched, they looked more like heavy storks than anything we had ever seen. The four birds flew seemingly slowly, but in reality at a great pace, and steered straight for my friend, who fired at the largest as it passed over his head. Down came the great bird an awful crash behind him. We ran up to it and found that it was a young male, perhaps a year old, weighing about fifteen pounds (old males sometimes scale over thirty pounds), and wanting the beautiful "whiskers" which adorn the full-grown male. It was only winged, but made no attempt to run away, and when we approached, it pecked at us, and uttered a hissing sort of bark.

We spent another day after bustard, far from the river, in a country studded with small round-topped hills, covered at the time of our visit with clover and stubble. Bustards seemed plentiful here, and we soon found a party of thirteen and another of four. We lay flat in the stubble on the slopes of the hills, while the men rode round to drive the birds. But the drive was not successful, and owing to the long flight taken by the bustards, and the nature of the ground, it was impossible to mark them down.

Our last experience with bustards was late in May. We left our boat and the river and proceeded to ride across a vast plain, covered with short, brown, sunburnt grass. We had gone some distance when a great sheet of water suddenly appeared in front of us. The sun was behind us and covered with clouds, and the distance was remarkably clear. Miles beyond the water we could see trees and houses, and further off still a low range of hills, all of which were clearly reflected, while a large herd of cattle, about a mile away, seemed to be standing knee-deep in the water—so perfect was the reflection.

We pointed it out to our men, but they laughed and said there was no water for miles. "Nonsense," said we, "there it is; can't you see it?" They laughed again. We took our binoculars, and still saw water clearly, but the glasses showed it further away instead of nearer. We rode towards our lake, but it receded and receded until it disappeared altogether, and the burnt-up plain appeared as dry and parched as before.

On this plain were a number of sandgrouse. They were very wild and difficult to get near. Their sandy colour harmonised so perfectly with the brown grass that it was impossible to see them until they flew up and away like rockets, and so we could not use the stalking horse to approach them. However, several flocks allowed us to come near enough for us to identify them—the black-bellied sandgrouse* by its black belly, which is very conspicuous when the bird is flying, and the pin-tailed sandgrouse† by the long pointed feathers in its tail.

At length we reached a great field, strongly fenced, and overgrown with rank grass and weeds as high as our horses' withers. Here we hoped to find the little bustard,‡ but careful search was difficult owing to the swarms of horse flies, as large and as yellow as hornets, and with a bite that was villainous even through our clothes. Moreover, the field contained a number of magnificent black bulls of famous fighting breed, which were enraged by the flies and required constant discouragement with stones or clods of earth. After half-an-hour's search we found a little bustard, which ran swiftly through the long grass and then flew up about a hundred yards away. In general colouring it reminded us of the willow grouse in autumn, by reason of its brown back and conspicuously white wings, but the flight was altogether peculiar. The bird never seemed to raise its wings above its body, but keeping them arched downwards, beat them rapidly, and so flew in an even slope until high up in the air.

After further search we surprised a great bustard, which also ran from us, and so effectually hid itself in the thick tangle of vegetation that we failed to induce it to fly or to find it again. This bird may have been a female with eggs somewhere in the field, or it may have been a male incapable of flight. Towards the end of May the great bustard loses its quill feathers for a time, and has then to

* *Pterocles arenarius.* † *Pterocles alchata.* ‡ *Otis tetrax.*

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seek safety in running and hiding. This fact may have given rise to the notion that the bird always runs and can be hunted with dogs. Except just at the time of the moulting of the old quills and the growing of the new, the great bustard could scarcely be coursed with dogs since it takes to its wings on the slightest alarm, and is capable of powerful and sustained flight.

On our return route to the river we passed through field after field of rich pasturage containing bulls of every age, all jet-black, of the finest fighting breed in Spain—that of the Marques del Sartillo.

In concluding these papers on our trip to the Guadalquiver, I have thought that a list of the birds which we found would be interesting, and perhaps of some value, to the systematist or to the future traveller in the district. Only those birds which we identified beyond all doubt have been inserted, and dates considered as interesting have been added. In noting these dates it must be borne in mind that April 2 was the first date we began collecting, April 4 was the first date in the *marismas*, and May 19 the last.

The district includes the country within a few miles of the Guadalquiver from Seville to its mouth at San Lucar.

LIST OF BIRDS: GUADALQUIVER, APRIL AND MAY, 1898.

NOTE.—*In the following list an asterisk signifies that the bird was obtained, and a dagger that the eggs were found.*

* *Turdus musicus*, Song Thrush.—A few seen. Latest date (bird), April 11.
Turdus merula, Blackbird.—Not common.
* *Saxicola albicollis*, Black-eared Wheatear.—Local.
* *Pratincola rubetra*, Whinchat.—One pair only April 14.
* † *Pratincola rubicola*, Stonechat.—Abundant. Fresh eggs and fledged young, April 2.
* *Ruticilla phœnicurus*, Redstart.—Very few. Latest date (bird), April 30.
Ruticilla titys, Black Redstart.—A few.
* *Daulias luscinia*, Nightingale.—Very common. Earliest date (bird), April 2.
* *Sylvia cinerea*, Whitethroat.—Common. Earliest date (bird), April 2.
* *Sylvia atricapilla*, Blackcap.—Common.
* *Sylvia hortensis*, Garden Warbler.—A few. Earliest date (bird), April 11.
* *Phylloscopus sibilatrix*, Wood Warbler.—One only April 29.
* *Phylloscopus trochylus*, Willow Warbler.—Fairly common.
* *Sylvia subalpina*, Subalpine Warbler.—Fairly common.
* *Aëdon galactodes*, Rufous Warbler.—Fairly common. Earliest date (bird), May 5.
Acrocephalus streperus, Reed Warbler.—One only seen and two nests found, May 21.
* † *Acrocephalus turdoides*, Great Reed Warbler.—Abundant. Earliest dates—(bird), April 4; (eggs), May 18.
* *Acrocephalus aquaticus*, Aquatic Warbler.—One only April 13.
Cisticola cursitans, Fantail Warbler.—A few seen.
Parus major, Great Tit.—A few seen.
Parus cristatus, Crested Tit.—Two seen, April 16.
* *Moticilla flava*, Blue-headed Wagtail.—Abundant.
* *Anthus campestris*, Tawny Pipit.—Small flocks, April 30 and May 1.
* *Oriolus galbula*, Golden Oriole.—Not common. Earliest date (bird), April 16.
* † *Lanius meridionalis*, Southern Grey Shrike.—Local. Nestlings and fresh eggs, April 2.
* † *Lanius pomeranus*, Woodchat.—Abundant. Earliest dates—(bird), April 2; (eggs), May 11.
Muscicapa grisola, Spotted Flycatcher.—Abundant. Earliest date (bird), May 2.
* *Muscicapa atricapilla*, Pied Flycatcher.—Abundant. Earliest date (bird), April 11, latest date (bird), May 5.
Hirundo rustica, Swallow.—Abundant.
Chelidon urbica, House Martin.—Abundant.
Cotile riparia, Sand Martin.—A few.
Ligurinus chloris, Greenfinch.—A few.
Carduelis elegans, Goldfinch.—Abundant.
Passer domesticus, House Sparrow.—Abundant in villages.
Fringilla cœlebs, Chaffinch.—A few.
* *Emberiza miliaria*, Corn Bunting.—Abundant in cultivated districts.
* *Emberiza hortulana*, Ortolan Bunting.—One only April 30.
* † *Sturnus unicolor*, Sardinian Starling.—Fairly common. Fresh eggs, April 28.
* † *Pica rustica*, Magpie.—Common locally. Earliest date (eggs), April 26.
* † *Cyanopica cooki*, Spanish Magpie.—Abundant locally. Earliest date (eggs), May 11.
* † *Corvus monedula*, Jackdaw.—Common locally. Earliest date (eggs), April 22.
† *Corvus corax*, Raven.—Fairly common. New and empty nest, April 11; fresh eggs, April 26; incubated eggs, May 11.
* *Galerita cristata*, Crested Lark.—Abundant in cultivated districts.
* *Alauda arvensis*, Sky Lark.—One only April 8.
* *Alauda arborea*, Wood Lark.—Two only April 16.
* *Calandrella brachydactyla*, Short-toed Lark.—A few.
* † *Calandrella bætica*, Andalucian Short-toed Lark.—Abundant in *marismas*. Earliest date (eggs), April 4.
* † *Melanocorypha calandra*, Calandra Lark.—Abundant. Earliest date (eggs), April 4.
Cypselus apus, Swift.—Abundant. Large migration. May 6.
Cypselus melba, Alpine Swift.—Many seen April 2.
* *Caprimulgus ruficollis*, Red-necked Nightjar.—Common. Earliest date (bird), May 3.
* *Jynx torquilla*, Wryneck.—One only April 15.
* *Gecinus sharpii*, Spanish Green Woodpecker.—Common locally.
* *Coracias garrulus*, Roller.—Common.
* *Merops apiaster*, Bee-eater.—Abundant. Earliest date (bird), April 5.
* *Upupa epops*, Hoopoe.—Common.
* *Cuculus canorus*, Cuckoo.—Fairly common.
Coccystes glandarius, Great Spotted Cuckoo.—Local.
* *Strix flammea*, Barn Owl.—One only.
* *Athene noctua*, Little Owl.—Common.
Gyps fulvus, Griffon Vulture.—Common.
Vultur monachus, Black Vulture.—Rare.
* *Neophron percnopterus*, Egyptian Vulture.—Common.
* † *Circus æruginosus*, Marsh Harrier.—Fairly Common. Earliest date (eggs), April 5.
* † *Circus cinereaceus*, Montagu's Harrier.—Abundant. Earliest dates—(bird), April 5; (eggs), May 13.
* † *Aquila adalberti*, Spanish Imperial Eagle.—A few.
Circaëtus gallicus, Serpent Eagle.—Fairly common.
* † *Milvus ictinus*, Kite.—Very common. Young in down, April 16.
* † *Milvus migrans*, Black Kite.—Abundant. Earliest date (eggs), April 22.
* *Falco peregrinus*, Peregrine.—Two only, April 9 and 23.
* † *Falco tinnunculus*, Kestrel.—Common.
* † *Falco cenchris*, Lesser Kestrel.—Common. Fresh eggs, May 21.
* *Ardea cinerea*, Common Heron.—A few. Latest date (bird), April 13.
* † *Ardea purpurea*, Purple Heron.—Abundant. Fresh eggs, April 5 and 23.
* *Ardea garzetta*, Little Egret.—Common locally.
* *Ardea bubulcus*, Buff-backed Heron.—Very common.
* *Ardea ralloides*, Squacco Heron.—A few.
* † *Ardetta minuta*, Little Bittern.—A few. Earliest date (eggs), May 21.
† *Ciconia alba*, White Stork.—Abundant.
* *Plegadis falcinellus*, Glossy Ibis.—Common locally.
* *Platalea leucorodia*, Spoonbill.—Fairly Common.
* *Phœnicopterus roseus*, Flamingo.—Abundant.
* † *Anas boscas*, Mallard.—Common.
* *Anas strepera*, Gadwall.—A few. One shot April 30.
* *Nettion crecca*, Teal.—A few. One shot April 6.
* *Mareca penelope*, Wigeon.—A few.
* † *Anas angustirostris*, Marbled Duck.—Very common. Earliest date (eggs), May 18.
* *Columba palumbus*, Ring-dove.—Common.
* *Turtur communis*, Turtle-dove.—Very abundant. Earliest date (bird), April 23.
Caccabis rufa, Red-legged Partridge.—Common.
Pterocles alchata, Pin-tailed Sandgrouse.—Local.
Pterocles arenarius, Black-bellied Sandgrouse.—Local.
* *Rallus aquaticus*, Water-rail.—A few.
* *Gallinula chloropus*, Water-hen.—A few.
* † *Fulica atra*, Coot.—Abundant.
* *Otis tarda*, Great Bustard.—Common.
* *Otis tetrax*, Little Bustard.—A few.
* † *Oedicnemus scolopax*, Stone-curlew.—Common.
* † *Glareola pratincola*, Pratincole.—Very abundant. Earliest dates—(bird), April 7; (eggs), May 17.
* *Aegialitis hiaticula*, Ringed Plover.—Very common. Seen on last day in *marismas* (May 19.)

* *Aegialitis curonica*, Lesser Ringed Plover.—One only.
* † *Aegialitis cantiana*, Kentish Plover.—Abundant.
* *Squatarola helvetica*, Grey Plover.—Abundant. Earliest date (bird), April 27. Seen on last day in *marismas* (May 19).
* † *Vanellus vulgaris*, Lapwing.—Abundant.
* † *Recurvirostra avocetta*, Avocet.—Common.
* † *Himantopus candidus*, Stilt.—Abundant.
* *Tringa alpina*, Dunlin.—Common. Latest date (bird), May 14.
* *Tringa minuta*, Little Stint.—Common.
* *Tringa subarquata*, Curlew Sandpiper.—Common. Seen on last day in *marismas* (May 19).
* *Calidris arenaria*, Sanderling.—Fairly common. Latest date (bird), May 15.
* *Machetes pugnax*, Ruff.—Fairly common. Latest date (bird), May 3.
* *Totanus hypoleucus*, Common Sandpiper.—Common. Seen on last day on river (May 23).
* *Totanus glareola*, Wood Sandpiper.—A few. Earliest date (bird), April 12. Latest, April 25.
* † *Totanus calidris*, Redshank.—Very abundant.
* *Limosa belgica*, Black-tailed Godwit.—Several flocks. Large flock seen on last day in *marismas* (May 19).
* *Numenius arquata*, Curlew.—Fairly common.
* *Numenius phæopus*, Whimbrel.—Fairly common. Latest date (bird), May 5.
* † *Hydrochelidon nigra*, Black Tern.—Very common. Earliest dates—(bird), April 9; (eggs), May 17.
* † *Hydrochelidon hybrida*, Whiskered Tern.—Abundant. Earliest dates—(bird), April 9; (eggs), May 17.
* *Sterna anglica*, Gull-billed Tern.—Fairly common.
* † *Sterna minuta*, Lesser Tern.—Common. Earliest dates—(bird), April 13; (eggs). May 18.
* *Larus ridibundus*, Black-headed Gull.—One only May 17.
Larus fuscus, Lesser Black-backed Gull.—Fairly common on sea coast.
Larus marinus, Great Black-backed Gull.—Fairly common on sea coast.
* *Larus gelastes*, Slender-billed Gull.—Not common.

HIPPALUS AND ITS SURROUNDINGS.

By E. WALTER MAUNDER, F.R.A.S.

THE district of the moon represented in our plate, which is reproduced by the kind permission of Messrs. Loewy and Puiseux from their magnificent *Atlas Photographique de la Lune*, is one of especial interest. It shows us the region lying between the Mare Nubium and the Mare Humorum, and presents a great number of features which are of peculiar value in determining the relative ages of the different types of lunar formation.

The more westerly of the two seas, the Mare Nubium, is one of the larger of the great lunar plains, and only a small portion of it is included in the plate, yet that is sufficient to bring into prominence some of its most characteristic features. Thus its surface is seen diversified by numerous isolated ring-plains and broken by long ridges; whilst, as the photograph indicates with great clearness, it is further marked by long light streaks.

The most easterly sea, the Mare Humorum, is also only shown in part, but though much smaller than the Mare Nubium, the portion of it here seen is of great interest. The Mare Humorum is one of the smallest of the lunar seas, having an area about equal to that of England and Wales. Like the Mare Crisium in the western quadrant, to which it shows some features of resemblance, its borders are, for the most part, distinctly marked. The features, which in the photograph are the most striking, though they are usually by no means easy objects in the telescope, are the long ridges of sinuous form by which the gradual descent from the mountain borders of the sea to its lowest levels is broken up into terraces.

Between the two seas stands the wrecked walled-plain Hippalus, forming in its present condition a sort of bay or extension of the Mare Humorum. A spur of hills continues the rampart of Hippalus in the south-western direction, and connects it with a very distinct ring-plain Campanus, some thirty miles in diameter. The centre of this spur of hills is marked by a bright crater, Campanus A, which occupies as nearly as may be the centre of the plate. Beyond Campanus to the south-west again is another ring-plain, the twin of Campanus as to size and distinctness, but distinguished from it by its level interior, whilst Campanus shows a bright central peak and two crater pits, both clearly marked in the photograph.

Mercator and Campanus, and the mountains, which prolong their general line of direction to the south-west, divide the Mare Nubium from a small Mare, sometimes described as the Sinus Epidemiarum. This plain would be nearly rectangular in shape, and one hundred and eighty miles long by one hundred miles broad, if it were not for the invasion of a very striking ring-plain, seen in the centre of the south-side of the plate, Capuanus. To the east, the plain is bordered by a broad confused mountain chain, whilst to the north-east, a bright mountainous region, intersected by winding valleys, separates it from the Mare Humorum. A very striking promontory projects from this last mountain chain far out into the Mare Humorum, three chief peaks of the promontory being lettered as belonging to the Hippalus region, Hippalus α, μ, and B.

Proceeding north from Hippalus, the barrier between the Maria Nubium and Humorum consists of a mountain chain continuing in the same straight line the general direction marked by Mercator, Campanus, and Hippalus. This mountain region derives the names of its chief peaks and craters from the irregularly shaped walled plain, Agatharchides, on the north-west side of the range.

The principal features of the remaining part of the margin of the Mare are the three contiguous formations on the south-east. These are the two partially wrecked walled plains, Doppelmayer and Lee, and a bright and strongly ramparted ring-plain, Vitello.

The chief portion therefore of the region represented in the plate is lowland, and the various formations with which the plains are diversified stand, for the most, in clear relief, without confusion from crowding by neighbouring masses. And, as the eleventh day of the month was well advanced at the time the photograph was taken, the sun having just risen on Doppelmayer, the sunlight throws up most of the objects into the most favourable relief.

Here, as everywhere along the margins of the great plains, we are at once struck with the way in which the matter composing the surface of the plain has attacked, and more or less completely dissolved, the "seaward" rampart, if we may use the expression, of the great walled plains that border it. Hippalus, the fort that holds the border line between the Sea of Clouds, and that of Humours, is a conspicuous example. The south-eastern wall has been destroyed, and the floor brought to the same level as the invading plain. Lee and Doppelmayer on the other side of the Mare Humorum have also suffered, though less severely, and Capuanus on the Sinus Epidemiarum, though it has preserved the entire circle of its rampart, yet shows the influence of the invasive matter, in the way in which the western wall has sunk down; the entire formation seeming as if tilted over on its side like a stranded boat.

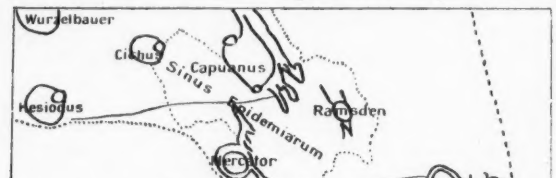
More striking still we have in the Mare Nubium two examples of ring-plains, Kies and Lubiniezky, which would appear to have sunk bodily in the invasive fluid; so low are their walls, and so complete the levelling of their interiors with the surrounding plain. Yet, that it is not always an essential that a ring should be overwhelmed by the substance of the plain we can see in the great ring-

plain Bullialdus, with its three satellites A, B, and C, all with bold unbroken ramparts, and all with their floors many hundreds of feet below the level of the *mare*.

With the reservation then of Bullialdus and its satellites it appears clear that generally speaking the great rings preceded the "seas" in order of time. The six rings mentioned above, Hippalus, Lee, Doppelmayer, Capuanus, Kies, and Lubiniezky, are amongst the relics of the earlier moon.

Dealing with the *maria* next, the succession of ridges on the Mare Humorum point out clearly what has happened there. The lines which these follow, however sinuous in detail, are manifestly circular and concentric in general type, and the crevasses which cut through Hippalus, and the country beyond, seem to carry on the same curves on a wider radius. It is scarcely possible to avoid the conclusion arrived at by Messrs. Loewy and Puiseux that the ridges and crevasses have a common origin.

It appears, then, that the basin now constituting the Mare Humorum has taken its present form by a series of



Sketch Map of Hippalus and its surroundings.

subsidences. Each subsidence was marked at its circumference by a crevasse, or fault, roughly circular in shape, and those crevasses which were formed earliest nearest the centre, and which surrounded the deepest subsidences, gave egress to the liquid or viscid matter of the interior, which welled up through them, filling up the crevasses, and forming ridges upon them. These outflows would naturally become less and less the further the crevasse was from the centre of the subsidence, and the less the depth to which the sinking at the crevasse had taken place, until at length a distance is reached at which no filling up of the crevasse takes place.

The crevasses, or "rills," then, are more recent than the "seas" as they are than the rings. That the rills are more recent than the rings is clearly shown by Hippalus itself, a deep crevasse cutting completely through it.

But the rills are not the most recent formation of all. As mentioned above, a bright crater, Campanus A, occupies the centre of the photograph. This crater stands right upon a rill, and completely interrupts it; and a more conspicuous crater, Agatharcides A, interrupts it further north. Neison, indeed, considers that it can be traced, greatly narrowed across both craters, but the photograph does not seem to bear this out.

The relation between the rills and the mountain masses is less clear. Neison describes this rill, and the one immediately to the east of it, as commencing at a small crater, Campanus *g*, east of Campanus. On the photograph, the influence of the rill can be traced quite unmistakably to the east of the crater, amongst the broken highlands which border the south of Mare Humorum, almost to the walls of Vitello. These highlands, therefore, are also earlier than the rills.

Another instance of a late ring-plain is seen in Ramsden, the peculiarly distinct ring-plain on the floor of the Sinus Epidemiarum. Three well-marked rills, in the form of a capital N, are clearly seen on the photograph to the north of the ring, and two of these are very distinctly prolonged beyond the ring to the south. Ramsden, therefore, like Campanus A, may be looked upon as one of the younger formations of the district.

The finest rill of the entire region can be traced on the photograph, but, from the illumination, is less evident than the rills of Hippalus. This is the great Capuanus rill, ϕ. It starts from the most easterly of the three great spurs thrown out from the north-east rampart of Capuanus, and strikes nearly due west in a right line, cutting through the mountain range connecting Cichus and Mercator, and extending to the wall of Hesiodus, a course of two hundred miles.

The great depth of the floors of Bullialdus and its satellites below the level of the *mare* would seem to show that they were formed later than the grey plain itself. If this be so, it may be inferred that the Mare Nubium was an older formation than the Mare Humorum, since the former had been completed whilst the internal forces were still powerful enough to give rise to so fine a ring as Bullialdus, on so much larger a scale than the little craters marking the ridges of the Mare Humorum and studding its lowest basins. And an attentive study of the district immediately around Hippalus, which separates the two "seas," will, I think, confirm this view.

Two other lines of structure shown in the plate may be alluded to. The first is the well-marked tendency to alignment in a S.W. and N.E. direction. The line through Cichus, Mercator, Campanus, and Hippalus, and carried on to Gassendi, the south wall of which is just seen on the edge of the photograph, seems fundamental to the whole region. It is plainly seen in Capuanus, both in the spurs projecting from the rampart outward, the markings on the floor, and the clefts through the wall. It characterises the general trend of the mountains east of the Sinus Epidemiarum, and bordering the Mare Humorum. It probably indicates the lines upon which the earliest lunar configurations were based.

Next in time, probably, come the great rings, so many of which are ranged on these fundamental S.W. and N.E. lines. Then come the subsidences which created the grey plains—that of the Nubium, probably considerably earlier than the Humorum. On these plains we find the lines of ridges and crevasses, the innermost indicating where the earlier sinkings took place. These were followed by the formation of ring-plains and craters along the lines of fault, and in other weak regions of the crust. Lastly, we find the white streaks—those in the present plate are for the most part of the system with Tycho for its centre—passing over all the preceding formations indifferently.

Letters.

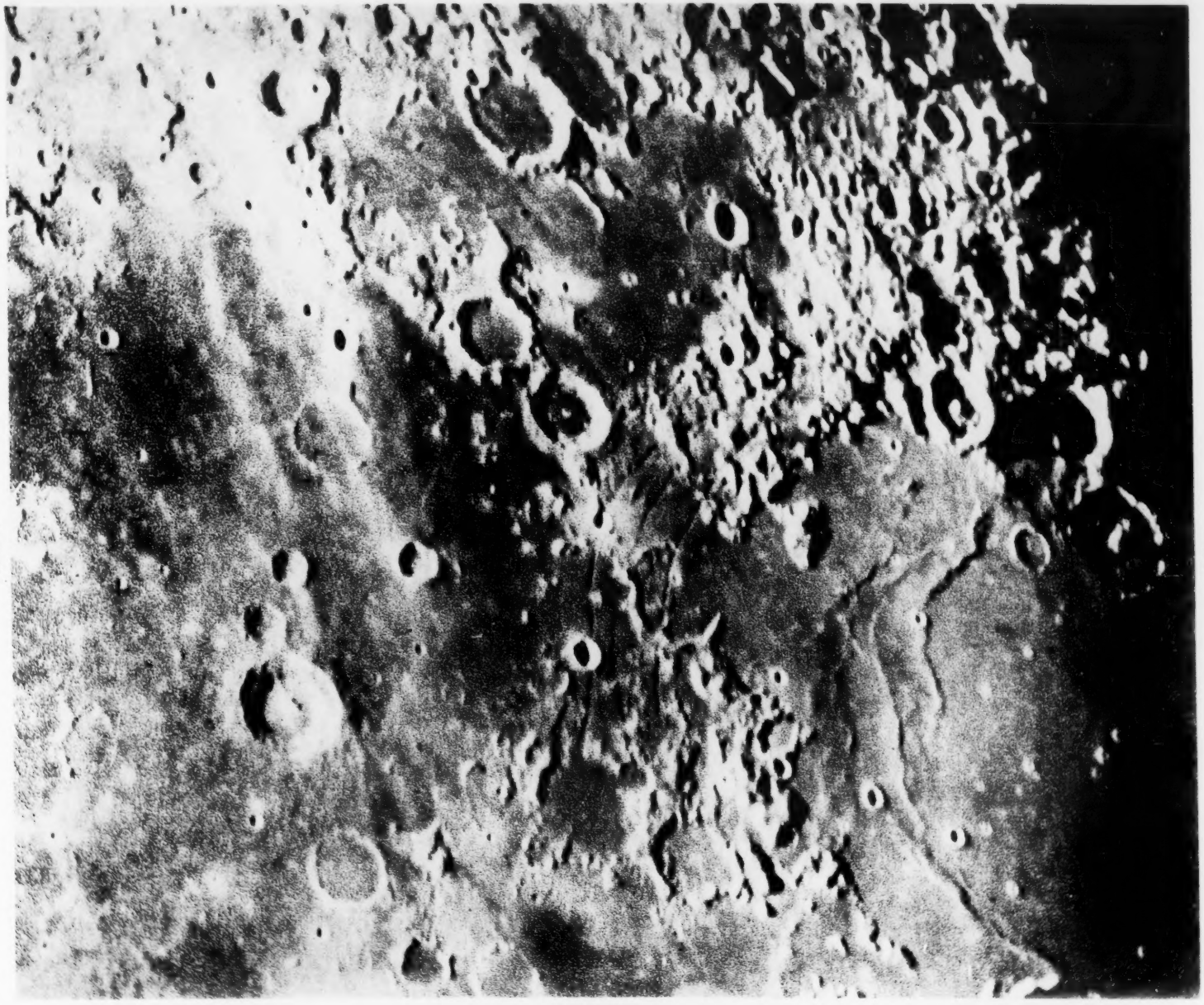
[The Editors do not hold themselves responsible for the opinions or statements of correspondents.]

IS THE STELLAR UNIVERSE FINITE?

To the Editors of Knowledge.

Sirs,—I fear Mr. Burns will draw down on his devoted

SOUTH.



WEST. EAST.

NORTH.

HIPPALUS AND ITS SURROUNDINGS.

From a Photograph taken 1896, April, 23d. 8·1h. Greenwich Mean Time, with the great Equatorial Coudé of the Paris Observatory.
Scale:—Diameter of Moon = 42 inches; Moon's Age, 10d. 15·7h.

head all the vials of your reviewer's wrath for indulging in speculations so similar to my own. He has, however, overlooked one hypothesis which I mentioned, viz., that the ether is finite; for, of course, if the ether be finite we could not receive either heat or light from stars situated beyond its limits. But if gravitation is independent of the ether, our motions might be dependent on these invisible bodies.

The thinning out of stars as we proceed to a considerable distance from the solar system could also be explained by supposing that the sun forms one member of a cluster of stars, and that the apparent thinning arises from our approaching the limits of this cluster or passing beyond them. But an infinite universe of luminous bodies ought, I think, to give us more light than we receive from the sky, if this light is transmitted to us without absorption, even though we were in the centre of the densest cluster.

Mr. Maunder, in his comment, is, I think, correct in stating that an infinite stellar universe does not imply that a right line drawn in any direction must ultimately meet a star. The infinite universe might, for instance, all be comprised within what I may call a moderate distance from the Galactic Plane, so that it would be easy to draw right lines towards the region of the Galactic Poles without encountering a star at any distance. But can this take place over the whole sky on the hypothesis that we are considering? Suppose the distribution of stars in any direction to be fairly uniform, the total light of the stars of the $n + 1$th magnitude will always exceed the total light of those of the nth magnitude, until the sky gets so covered with them that there is a very appreciable loss of light owing to one star getting in the way of another. If then the distribution continues to be fairly uniform (in a given direction) to infinity, must not the sky in that direction appear as one blaze of light?

W. H. S. MONCK.

THE SEAS OF THE MOON.

To the Editors of KNOWLEDGE.

SIRS,—Towards the end of his interesting paper which appears in your issue of November (p. 251) under the above title, Mr. J. G. O. Tepper says, "the finest, lightest dust must remain eternally undisturbed, except by the rude shock of a colliding meteor, or when ploughed aside by such, if gliding along after a very oblique impact." No mention is made of this sentence containing—if Mr. Tepper's theory be accepted—a most probable explanation of the "rays." The evidence appears particularly strong in view of the following facts:—

(1) The moon is without atmosphere, and therefore all meteors which collide with her would be unbroken and solid (not converted to gas) until they strike her surface;

(2) The "rays" cast no shadows;

(3) They appear brightest at full moon.

If this corollary to Mr. Tepper's theory is of any value, these "rays" should be gradually increasing in number, and particularly when, as will shortly be the case, the Leonid swarm of meteors is encountered.

I should be glad to hear whether the latter is the case, and of any evidence for or against the formation of the "rays" in the manner described.

Strathmore, Chiswick. LAURENCE B. TAPPENDEN.

TREES STRUCK BY LIGHTNING.

To the Editors of KNOWLEDGE.

SIRS,—Some years ago a tree in the grounds of my house, on the Brisbane River, in Queensland, was struck by lightning, with effects which bear out one of the views of your correspondent, Baron N. Kaulbars, of St. Petersburg, on the behaviour of trees struck by lightning. The tree was a Moreton Bay pine *(Auracaria Cunninghami)*, over one hundred feet high. About twenty-five feet from the ground an old piece of rope encircled it, the loose ends of which projected a few inches from the stem. This arrested the stream of rainwater flowing down the tree and drained it clear of the lower part of the trunk, the surface of which thus remained dry. At this stage of the storm lightning struck the tree but did no damage to the wet part of the trunk above the circlet of rope. But between the rope and the ground a groove was cut out of the tree. A strip of solid wood, about three to four inches deep and as many broad, together with the superimposed bark (and following a slight twist of the fibre of the wood), was burst out by the explosive force of the instantaneously superheated sap. The outward direction of the disruptive force was very clearly shown by still adherent splinters of wood.

The tree failed gradually, but did not quite die till nearly three years after receiving its paralysing stroke.

P. DE JERSEY GRUT.

National Liberal Club, Whitehall Place, S.W.,
26th October, 1899.

Obituary.

By the death of Mr. GRANT ALLEN on the 25th October, 1899, science loses one of her most popular exponents. Born at Wolfe Island, Canada, in February, 1848, he received the elements of a liberal education at various places—United States, France, Birmingham, and ultimately entered Merton College, Oxford, where he graduated B.A. in 1870. Embarking on an active career in life, Mr. Allen spent a few years in Jamaica as Principal of a college intended for the higher education of the negro. Returning to England, he settled in London and adopted literature as a profession, devoting most of his energy at this period of his life to science, always a favourite study with him to the last. While Mr. Allen was still heroically struggling to make popular science a vehicle for bringing grist to the mill, the late Richard A. Proctor founded our magazine, and in the earlier volumes of KNOWLEDGE may be found a great many of his most attractive papers—"Ants and Aphides," "Concerning Bats," "About Variation," "Among the Grasses," "The Dispersion of Seeds," "Plant Evolution," "The Stone Age Men," "A Naturalist's Year," and indeed a complete round of subjects which are of perennial interest to all lovers of nature, and they are comprised within the years 1881-1886. Among Mr. Allen's published scientific works may be mentioned "Physiological Aesthetics," "The Colour Sense," "Vignettes from Nature," and "The Evolutionist at Large." Fiction, however, was kinder to him than science from a commercial standpoint, but it is fair to say that although Mr. Allen frankly wrote such works as "The Woman who Did" and "British Barbarians" to suit the market in order to produce an income, he was always a man of science at heart, and he found a medium for the exercise of his great aptitude as a popular exponent of science in many illustrated monthlies. Prof. Yorke Powell, writing to the Editor of the *Oxford Magazine*, says: "Grant Allen was my friend for thirty years, and of the men I have known well, I have known few who were so fixed in their convictions, so absolutely true in their lives to these, and, at the same time, so tolerant and generous-minded toward those that differed from them. Allen was always ready to sacrifice himself for others, and his kindly help, whether of brain or purse, was prompt and ungrudging. To my mind he has, in spite of many interruptions caused by the

necessities of life, done something to advance the studies to which he gave his heart very early in his career. He was obliged to give much of his time to popular exposition, and he loved teaching. The ease and facility of his papers for general readers sometimes, I think, concealed from his readers the amount of care and thought he had given to the subjects he was treating. It has long been to me regretful that Allen had not the leisure that would allow him to pursue learning rather than romance; and I know that it was a real regret to him, though he was the last man to grumble at fate. He would have laughed at anyone who would have described him as in any way perfect, but he was an honourable man, a steady friend, and a good citizen, a sincere seeker after truth, and an honest worker, and to those who have known him his loss will assuredly be deeply and continually felt."

Conducted by Harry F. Witherby, F.Z.S., M.B.O.U.

The Food of the Hobby.—It is well known that the Hobby Falcon (*Falco subbuteo*) is an insectivorous bird, but it is known to persecute the *hirundines*, and even to catch the Swift itself. The true nature of the Hobby's food was, however, made pretty clear on the ground beneath a nest of these birds which I visited when away from home this summer. There was no doubt as to the identity of the species, for the old birds were well known to the people at the place. While I was there one of the old ones returned, and we heard a young one calling to it from a big tree. The castings under the nest were composed almost wholly of insect remains and short fur, presumably that of mice. There were a few feathers of other birds under the tree, but these may have been blown there from a distance, for they included rook and magpie feathers, and these large birds could hardly fall victims to a Hobby. A great quantity of the castings had been trampled by cattle resting in the shade, with the result that in places the ground was actually covered with the remains of beetles. The old Hobbies were accustomed to take a short flight, together with their young, to a clump of trees on a near hill, but at evening they all returned to the tree which held the nest.—Charles A. Witchell, Charlton Kings.

The Marsh Tit's Sense.—I grew some sunflowers this year for my fowls. Tits, of course, came for the seeds. I tried to scare them harmlessly, but in vain. I then set some horsehair nooses on the seed-heads. After several nooses had been broken, I caught a Marsh Tit (one of a solitary pair), and the same day a Great Tit. The latter was left hanging as a scarecrow, and two days later the surviving Marsh Tit came and perched within a foot of the corpse and within two yards of myself. It then took a seed from the seed-head from which the dead bird was suspended. Up to the time of writing this Tit has remained solitary. It still comes to the flowers. But the Great Tits left them alone after the hanging.—Charles A. Witchell, Charlton Kings.

Barred Warbler (*Sylvia nisoria*) in Lincolnshire.—I was fortunate enough to shoot, on October 17th last, an immature female of this species. It was on a nearly bare thorn bush, not far from the coast, at Marshchapel, and was not at all shy. A strong migration was in progress, grey crows, rooks, larks, and starlings, passing over to north-west all day, and the hedges and other cover along the coast were full of robins, goldcrests, redwings, great and blue tits, and other migrants. The weather had been fine, and the wind from the east since the 15th of October.—G. H. Caton Haigh, Grainsby Hall, Great Grimsby.

Young Cuckoo ejecting Young Meadow Pipit.—At the meeting of the British Ornithologists' Club, held on October 18th, Mr. Scherren exhibited interesting photographs of a young Cuckoo, taken at two separate stages of its work of ejecting a young Tit-lark from a nest. The nest was found and watched by Mr. John Craig, and the photographs were taken by Mr. Peat Millar, of Beith, N.B. These photographs are of considerable interest, as although the fact of the ejection of the offspring of its foster-parents by the young Cuckoo is well established, many people are still disbelieving, and a photograph forms incontrovertible evidence.

Two-barred Crossbill (Loxia bifasciata) in Sussex (*Ibis*, October, 1899, p. 647). At a meeting of the British Ornithologists' Club, held on June 21st, Mr. N. F. Ticehurst exhibited an example of *Loxia bifasciata* which had been obtained in East Sussex on February 23rd, 1899.

The Occurrence of the Sociable Plover in Ireland. By Edward Williams (*Irish Naturalist*, November, 1899, pp. 233-4). The claim of this bird to a place on the British list has hitherto rested upon a single example shot in Lancashire in 1860. Mr. Williams now records the occurrence of a second example shot on August 1st last at Robinstown, near Navan, County Meath. Mr. Williams considers the bird a female, in second year's plumage. *Vanellus gregarius*, which is closely allied to the Lapwing, inhabits the steppes of the Crimea and Turkestan, while in winter it travels to India, Ceylon and North-East Africa.

Fungoid Disease in Razorbill (*The Field*, October 7th). Mr. T. H. Nelson has sent a Razorbill, shot at the Tees mouth, to the editor of *The Field*. The bird's mouth showed a disease which, the editor remarks, is "closely analogous to, if not identical with, that which occurs so frequently in domestic fowls and pigeons, and resemble the diseases in trained hawks which is known to falconers as 'fromice.' It is a deceased condition of the mucous membrane in the head and throat." As far as we are aware, the occurrence of this disease in a wild bird has never before been recorded.

All contributions to the column, either in the way of notes or photographs, should be forwarded to Harry F. Witherby, *at 1, Eliot Place, Blackheath, Kent.*

Science Notes.

Mrs. Farquharson, of Haughton, is carrying on an active crusade in favour of admitting women to the full membership of learned societies. Although not agreeing with all Mrs. Farquharson's tenets, we see no reason why women should not be admitted to membership of the learned societies, provided always that they remain as ordinary members, and are debarred from executive positions.

An astronomical and scientific society, which is destined, we hope, to do some good and useful work, has been started under the presidency of Mr. Edward Bond, M.P.,

at Hampstead. The membership already numbers over eighty, and a reflecting telescope of ten and a half inch mirror, the gift of Colonel Heberden, has been erected for the use of the members in a small observatory on the East Heath. Mr. B. W. Martin, of 7, Holly Place, Hampstead, is the honorary secretary.

Notices of Books.

The International Geography. By Seventy Authors. Edited by Hugh Robert Mill, D.SC. Illustrated. (George Newnes.) 15s. Many books are now published on every branch of scientific knowledge, but it is rarely that a volume appears having characteristics which place it distinctly in advance of others of the same class. Such a volume is, however, now available for the student of geography in the work before us; no impartial critic, familiar with geographical literature, will hesitate to express this conviction. In his position as Librarian to the Royal Geographical Society, Dr. Mill has exceptional opportunities of knowing trustworthy authorities on the geography of any part of the world, and on the subjects of earth structure affecting the physical environment of man. The admirable discrimination he has used may be seen by a glance at the list of contributors to the present volume. With one or two exceptions it may be said that every page of the one thousand and fifty two which make up the descriptive portion of the book is the work of a leading geographer, distinguished above others for the special knowledge he possesses of the subject with which he deals. The list of contributors is so long that it cannot be enumerated here, but the value of the foregoing remark will perhaps be better appreciated when we say that Dr. Downing, the chief of the *Nautical Almanac*, deals with mathematical geography, Prof. J. Arthur Thomson with the distribution of living creatures, Prof. Grenville Cole with Ireland, Sir John Murray with the oceans, the Right Hon. J. Bryce with the South African Republic, and Dr. Nansen with the Arctic Regions, to mention only six of the seventy authors. Dr. Mill has not only edited the volume, but has written a number of the sections and has translated several of the chapters by foreign contributors. He has evidently spared no pains in designing the work and securing uniformity of treatment, and has succeeded to a degree which would almost have seemed impossible to anyone familiar with editorial difficulties. The illustrations are not of a pictorial character, being sketch maps and diagrams to assist the reader to understand the special features described in the adjacent text. In this respect, as in others, the editor has acted wisely, for if an attempt had been made to combine atlas, picture book and text book, the resulting work would certainly have been unsatisfactory. To indicate the scientific scope of the volume, we may add that Dr. Mill defines geography as "the exact and organized knowledge of the distribution of phenomena on the surface of the earth, culminating in the explanation of the interaction of man with his terrestrial environment." Geography only becomes a science when this broad conception of it is taken; and the present volume will help to educate the public to recognize that principle. But putting aside educative influences, we confidently state that the work is a unique contribution to geographical literature, and if a library had to be limited to a single work on geography, this ought to be the selected book.

An Illustrated Manual of British Birds. By Howard Saunders, F.L.S., F.Z.S., etc. Second edition. (Gurney & Jackson.) Illustrated. 21s. This book, which has been issued in monthly parts, to which we have already drawn attention, is now completed. In this second edition of the well-known "Manual" Mr. Saunders' task has been to sift a mass of evidence regarding a number of birds claimed to be new to the British list since the first edition was published ten years ago. Of these seventeen have been accorded places, thus bringing the total up to three hundred and eighty-four. Besides this the whole of the book has been brought up to date, which has entailed a great deal of rewriting—an exceedingly difficult task when the description of each species is limited to two pages. Another new feature in the book is the re-drawing of many of the figures. This was a much-needed reform, and Mr. G. E. Lodge has done his work on the whole well, many of the drawings being most beautiful, but in some cases, and notably in the figure of the Caspian Plover on page 537, we are sorry to note a marked falling off from the painstaking and accurate detail which are generally such a characteristic of Mr. Lodge's drawings. Although there are a great number of new figures there are still many old ones which should never have found a place in the second edition. Of these bad drawings we would especially draw attention to the figures of the Long-eared Owl (p. 293), the Sparrow Hawk (p. 333), and the Arctic Tern (p. 649). One of the most valuable portions of the book is the comprehensive account of the geographical distribution of each species. This feature makes the book of great use to the traveller. In a few cases the author might have given us a few words more, as for instance in the case of the Common Sandpiper, concerning the distribution of which north of the Arctic Circle he tells us nothing. The statement on p. 192 that the Lesser Redpoll is unknown on the Continent to the north of the Baltic is difficult to understand in conjunction with a statement made by Mr. Harvie-Brown in the *Ibis* for 1873, p. 64. Mr. Harvie-Brown, in writing of the birds of the Archangel, said that the Lesser Redpoll was "perhaps the most abundant bird in the Archangel district . . . . breeding plentifully in the gardens in the town." Mr. Saunders has no space to tell us much of the habits of birds, but the essential points are introduced. In this connection we should like to draw his attention to two small points. On p. 560 he says of the oyster-catcher that "on rocky coasts each pair inhabits a certain district." This is not according to our experience. On the west coasts of Scotland and Ireland we have found a great many breeding in close proximity on small rocky islands, the "nests" in some cases being within a few yards of each other. It is mentioned that the Sandpipers often perch on trees and posts, but it is not mentioned that the whimbrel, godwit and others do so, although with them the habit seems just as usual. In conclusion, we may point out that to write such a book as this on British birds is no mean task, and as the best proof of how accurate and full of information it is we may say that the first edition became quite indispensable to every British ornithologist. We are quite certain that this second edition will become equally so, and we heartily recommend everyone interested in birds who does not know the book to immediately procure it.

The Process Year Book for 1899. Edited by W. Gamble. (Penrose & Co.)

Photograms of the Year 1899. Compiled by the Editors of *The Photogram*, assisted by A. C. R. Carter. 3s. net. (Dawbarn & Ward.)

That each of the two books before us is so excellent, both in its examples of photograms and its reproduction of them, relieves the obtrusive fact that the year 1899 has not given us much that is new in photography. We can safely say that we have not seen more beautiful illustrations than some of those contained in these two annuals. The superiority of colour over black and white is manifested in the "Process Year Book," which contains several very successful tinted illustrations, a green tint, for instance, lending a distinct charm to some rustic scenes. On the other hand, the three-colour work shown is very poor indeed—no advance on that of former years. On the whole "The Process Year Book" is a wonderful production, and the numerous articles on all manner of process work are very profitable reading. No one will regret that "Photograms of the Year" is double the size of the four previous issues, for hardly an unworthy photogram has been admitted. The articles are fragmentary, but good, and the criticisms painstaking. The use of a substitute for "Art printing paper" has had the unfortunate effect of destroying pure high-lights in the majority of the illustrations, a result much to be deplored in a book of this kind.

The Soluble Ferments and Fermentation. By J. Reynolds Green, SC.D., F.R.S. (Cambridge University Press.) 12s. No more instructive example of the gradual growth of modern views on scientific questions is to be found than that provided by the repeated modification of theories put forward to explain the various problems connected with the phenomena of fermentation. As the results of researches have shown that explanations previously accepted were inadequate to account for all phenomena, the old theories were either discarded or reformulated. In early times fermentation meant any process accompanied by a copious evolution of gas, and some old writers went so far as to

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class under fermentation the effervescence which characterises the action of a mineral acid on a carbonate. But we have moved very far since then. To adequately recapitulate all the changes in the opinions held by chemists and physiologists of the nature of fermentation, and to provide a satisfactory account of modern work on this interesting study, it is necessary, as Prof. Green's book shows, to have a volume of nearly five hundred pages. The aeration of dough and the common production of alcohol were very early correctly associated with fermentation, and towards the end of the sixteenth century putrefaction was seen to have much in common with the other two processes, but it was not recognized till 1659 that they all differed widely from mere effervescence. The deposit observed as an invariable accompaniment of fermentation was first microscopically examined by Leuwenhoek about 1682, but he failed to recognize its vegetable nature—it was not till about 1825 that Cagniard de Latour made this quite clear. This distinguished observer concluded that the globules he saw under the microscope disengaged carbon dioxide and fermented the liquid by some effect of their vegetation. Meyen, later, pronounced the organism a fungus. The more satisfactory views of Pasteur followed, and after much research by many workers, in 1833 Payen and Persoz extracted from germinating barley the now familiar diastase which they distinguished as an "unorganized" ferment. In 1845, Mialhe prepared diastase from saliva. In 1836, Schwann demonstrated the existence of pepsin in gastric juice. And so the idea of two classes of ferments was led up to—"organized" ferments and enzymes—that is, unorganized or soluble ferments. Prof. Green traces at some length all these stages in the history of the study of fermentation, and shows that the present definition of the process must be "the decomposition of complex organic material into substances of simpler composition by the agency either of protoplasm itself or of a secretion prepared by it." Though of necessity written in somewhat technical language, the earnest student will find in this well printed volume a clear and interesting account of the chemistry and physiology of most important processes in the economy of the organic kingdom.

The History of the European Fauna. By R. F. Scharff, B.SC., PH.D. (Walter Scott.) 6s. An example from Dr. Scharff's introductory chapter will indicate the nature of the questions with which he deals in this very readable volume. The Arctic hare "is in the British Isles confined to Ireland and the mountains of Scotland; and if it were not for the fact that its bones have been discovered in a cave in the south-west of England, we should never have known that, formerly, it must have inhabited that country as well." Its bones have not been found in Southern Europe, but the nearer we get towards the North Pole the more abundant its remains become. Hence it has probably reached its present habitat from the north. Throughout the book geology and zoological distribution, as we know it to-day, are both utilised in explaining the history of typical European fauna. It is demonstrated that the former distribution of land and water is intimately connected with the origin of the animals under consideration, and these changes are traced by observations on the actual areas occupied at the present time by mammals, snails and earthworms. The larger problem is approached by a preliminary careful consideration of British fauna, then after reviewing the Arctic fauna, the great migrations known as Siberian, Oriental, and Lusitanian are explained and detailed, and the book concludes with an account of the Alpine fauna. The maps which indicate in a general way the extent of former seas and continents are not intended to be strictly accurate, but admirably serve to illustrate the broad features of the distribution of land and water during the chief geological epochs. Dr. Scharff's book will provide anybody who wishes to learn with a clear and instructive account of the distribution of the various forms of animal life in time—a subject quite as fascinating as the kindred one of their distribution in space.

The Birds of Breconshire. By E. Cambridge Phillips, F.L.S., M.B.O.U. (Brecon: Edwin Davies.) Illustrated. Books dealing with the avi-fauna of a county—and now there are many—are always useful and instructive, and the one now before us is no exception to the rule. Mr. Phillips has been a careful recorder of the birds found in his county for many years past. Seventeen years ago he printed for private circulation a list of the birds of Breconshire, of which the present book may be called a revised and enlarged edition. It is very encouraging to learn that since the first edition appeared, several birds, and among them some which are becoming rare in this country, have increased in numbers in Breconshire. On the other hand it is deplorable that a fine bird like the red kite, which was once very common in England and Wales, now, in the words of the author, "hardly holds its own in Breconshire," and where is it to be found in England? The harriers, too, once common, are now nearly extinct in Breconshire. The book is provided with a summary and a sufficient index which becomes a necessity owing to the somewhat strange classification adopted. Residents in the county taking any interest in birds should certainly procure the book, while ornithologists generally will find it a useful and interesting addition to other county avifauna.

The Wheat Problem. By Sir William Crookes, F.R.S. (Murray.) Paper, 2s. 6d.; cloth, 3s. 6d. Sir William Crookes dwelt, in detail, on the wheat problem in his address before the members of the British Association in September, 1898, and the severe criticisms hurled at him since that time have resulted in inducing Sir William to issue this book—partly in self-defence, and to some extent as an amplification of the views expressed in his address. "Having pondered disputed points," says Sir William, in the preface, "I cannot in any material degree modify my estimates of the future producing capacity of the wheat fields of the globe. . . . If at the end of another generation of wasteful culture my forecast is invalidated by the *unforeseen*, I cheerfully invite friends and critics to stone me as a false prophet." The first fifty pages contain the original address; twenty-five pages are occupied with a review of our present and prospective food supply; about eighty pages set forth replies to various critics. Quite apart from controversial matters, however, the book is a useful one to all interested in the production of wheat both from the commercial and scientific points of view. Although the author has given us an imposing array of facts, there are also some statements intermingled therewith that will not withstand the criticism of those whose business brings them into close relations with the soil and the markets where produce is distributed. For many years back it has not been worth while to bring new land under cultivation in England, or to farm high in other countries. But let prices rise, make it worth the farmer's while, and, even with present knowledge, the starvation which Sir William so confidently predicts can be kept at bay for long years to come.

Energy and Heat. By John Roger. (Spon.) Illustrated. 2s. This little book, comprising some thirty-six beautifully printed pages, in all the glory of cloth boards, has been on our table for some weeks now. It came to hand at an unfortunate time—a time when we were suffering from too great an intensity of heat, and, in consequence, seemed to be without energy. In the second line of the introduction we note the expression "so-called latent heat," and our thoughts fly back to a period prior to our own existence; in fact we remember that Cavendish objected to the use of the term. In the first chapter—"Heat"—we read: "It may, however, be transmitted readily from one body to another, the tendency being to preserve a uniform degree of pressure"!! and, later: "Therefore it may be said that heat is elastic, or compressible." One of Davy's very earliest works would set Mr. Roger right on this point. Chapter II. is headed exactly in this way: "Temperature (*Pressure*)." Now which is which? We tackle the chapter, hoping to find out. The "*Theory* of the sponge," otherwise known as the Caloristic doctrine among the ancients, continues to hold the floor, with just one improvement—pressure means temperature!! In Chapter III. we have "As a thermometer is a measure of the temperature." Now, common sense at once tells us that it is the *reading* of the thermometer which is this, and Mr. Roger, to be consistent, should have written pressure here for temperature. But that latter error crops up more than once; we never know whether he has or has not abandoned his convention for the moment. The concluding sentence of this chapter refers to the latent heat of steam, and we find: "The heat, therefore, has not become latent, but has simply been diffused over a larger volume." In other words, the sponge theory is clung to tenaciously. Following on, and, indeed, based on all this a determined effort is made to show that the steam engine is a more efficient apparatus than we usually deem it. Later—page 35—it is suggested that frictional heat is due to induced electrical currents. Finally, if Mr. Roger is a very young writer, we would suggest his trying again, but

if this hypothesis be not correct, he is certainly a very careless writer, and should bring himself to admire the "policy" as well as the theory "of the sponge." Our remarks are longer than they need have been but for one fact—there is just enough of sense in the book to make it really dangerous.

Bird Life in an Arctic Spring. The Diaries of Dan Meinertzhagen and R. P. Hornby. (Porter.) Illustrated. This book is a very interesting and touching memorial of a young naturalist cut off at the very beginning of a career which was full of usefulness and had promise of considerable distinction. The book is chiefly composed of young Meinertzhagen's diary, published just as it was written during a three months' ornithological trip to Finnish Lapland. The diary is completed by R. P. Hornby, the friend who accompanied him. It is very interesting, and shows what a keen and intelligent field naturalist the young author was. A chapter is added on his life at home and at school, and a description is given of the wonderful collection of living eagles and other raptores which Meinertzhagen formed at Mottisfont Abbey, the residence of his father. Perhaps the chief interest in the book is contained in the drawings of birds, which have been reproduced from paintings and careful pen and ink drawings by Meinertzhagen. Some of them are faithful copies from the works of well-known bird painters, but most are original drawings from Nature. They are all excellent, and had the young artist lived we feel certain that his work would have rivalled that of the most famous bird painters.

Little Auks, from "Bird Life in an Arctic Spring."

Report of the Australasian Association for the Advancement of Science, held at Sydney, 1898. Edited by Dr. A. Liversidge, F.R.S. Our scientific friends at the Antipodes, in this formidable volume of addresses, reports of research committees, extracts from the minutes of meetings, lists of officers and members, objects and rules of the association, and so on, show their appreciation of the modes adopted for the advancement of science in the mother country—they apparently adopt our methods without an effort to modify the effect by shearing the prototype of its many faults. And so we are having additional periodical volumes, each about the size of a family Bible, embracing every imaginable subject, arranged, or disarranged, higgledy-piggledy, for the hungry student to browse upon at his own sweet will, or have the will squeezed out of him by the ever-increasing avalanche of weighty tomes, the matter of which is too often duplicated and rough-hewn, instead of well-sifted and polished. It would have been to the lasting credit of our scientific workers over the sea if they had infused more of the original, and adopted less of the imitative, element in publishing their proceedings. As they are, however, the volumes, like our own reports, will be more ornamental than useful in our libraries. The keenest thirst for knowledge, and the most determined effort are needed for the extraction of all the available information on any given subject from these heterogeneous records of scientific research.

Birds. By A. H. Evans, M.A. (Macmillan.) Illustrated. 17s. This book forms Vol. IX. of the now famous library known as the Cambridge Natural History. The author has endeavoured, and we think successfully, to give a "short description of the majority of the forms in many of the families, and of the most typical or important of the innumerable species included in the large passerine order." The book only contains some six hundred pages, printed in large clear type, so that one cannot expect a detailed description of the birds mentioned, and of course to include even the names of all the known species would have been an impossibility. Mr. Evans has arranged his book very cleverly, and imparts a great deal of sound information in a very small space. An introductory chapter deals briefly with the structure of birds, their classification, geographical distribution, and migrations. The birds are then dealt with in groups, an ascending scheme of classification being adopted, and a brief summary of the general structure and habits of each group being prefixed. When dealing with a family or genus, the author has been wise in first giving a fairly detailed description of the species best known to English readers, and then proceeding to show how other species differ from it. Mr. Evans has performed a very difficult and laborious task admirably the information imparted being, both as regards selection and accuracy, all that could be desired in such a book. To ornithologists generally, and especially to the travelling ornithologist, it should prove extremely useful, and giving as mentioned brief descriptions of the plumages of birds, it might be used as a companion to Prof. Newton's well-known "Dictionary of Birds." The drawings, almost all by Mr. G.E. Lodge, must be classed amongst the best work done by that accurate and painstaking artist.

Notes upon the Romano-British Settlement at Chigwell, Essex. By J. Chalkley Gould. (Epping Forest Museum: Chingford.) Illustrated. 6d. This little pamphlet contains a description of urns and various other vessels which have been found at Chigwell, an early Roman settlement of the period, probably 43-410 A.D. The pottery is mostly in fragments, but here and there vessels were found carefully placed, and may have contained funeral remains after cremation of the body. Coins were scarce. The illustrations are excellent, and the little brochure will therefore be valuable to those interested in archæology.

The Geography of Mammals. By William L. Sclater, M.A., and Philip L. Sclater, M.A., PH.D., F.R.S. (Kegan Paul.) 12s. net. The political divisions of the earth's surface become so firmly fixed in the mind as the result of the ordinary school instruction in geography that it generally comes as a surprise to the ordinary person to hear that more logical boundaries than those decided by historical events are forthcoming. The distribution of animals and plants on the land areas of the globe has been found to afford quite a different partition from that which political geography recognises. "Europe, for instance, the most important of all the continents politically speaking, is for zoological geographers, as well as for physical, but a small fragment of Asia." Taking the amount of similarity and dissimilarity of animal life as their guide, and for this purpose selecting the mammals, as the "most highly organised and altogether the best known group of the animal kingdom," the authors examine the geographical distribution of this class of animals over the world's surface, and by this means arrive at regions widely different in extent and significance from those of the school. In this way a division of the land-area of the globe into six areas is obtained. This division into the regions known as Australian, Neotropical, Ethiopean, Oriental, Nearctic, and Palæarctic, was proposed by Dr. P. L. Sclater in 1857, and though not universally adopted, is pretty generally recognised as a good basis for a classification of the geographical distribution of animals. The book provides a good account of all six regions, of each of which a clear and coloured map is supplied. Separate chapters deal *seriatim* with the distribution of the chief mammalian orders, and the abundant illustrations greatly add to the attractiveness of what should prove a very useful

addition to scientific literature. The tables of genera with which the chapters are provided have been prepared with the assistance of Messrs. Beddard and De Winton.

Cries and Call Notes of Wild Birds. By C. A. Witchell. (Upcott Gill.) 1s. This little book, which has been on our table some time, has unfortunately been overlooked. It merits a notice if only on account of the author being the pioneer and one of the only systematic students of bird-song. The purpose of the present book is "to so describe the notes of our most familiar birds that the reader may easily acquire a tolerably intimate knowledge of them, and thus be led to make independent observation." The book is divided into four portions, dealing with town birds, woodland birds, upland birds, and waterside birds. Only the commoner species are dealt with, and the reader is often helped with musical notation. With the town and woodland birds our author deals at some length, and in a very interesting way, and for his useful and instructive notes on these species the book is certainly one to be invested in by every bird lover. But Mr. Witchell is evidently little acquainted with the cries and call notes of the shore and sea birds.

The December number of *The Studio* will include a sixteen page supplement devoted to illustrated reviews of the most important new books of an artistic character.

We have on our table a Diary for the year 1900. It contains a monthly ephemeris, celestial phenomena for the year, astronomical summary, principal observatories and refractors of the world, and all the tables ordinarily required in the observatory, as well as postal and other information of general utility. The Diary affords writing space to the extent of one whole page per day, and although published especially for the Royal Navy, will be found exceedingly useful to all who are interested in astronomy. The book may be obtained of the publishers of "Lean's Royal Navy List," 326, High Holborn, London, and the price is three shillings.

Messrs. Lumière & Son's photographic plates and papers are well known to, and appreciated by the photographing public, but possibly their chemicals have not hitherto had a like appreciation. This, however, ought not to be, and we imagine that such names as diamidophenol, diamidoresorcine, hydramine, paramidophenol (which glare at us from Messrs. Lumière's catalogue), will soon be as familiar to the photographer's ear, and we trust as facile to his jaw, as his old friend pyro. Messrs. L. Gaumont & Co., 25, Cecil Court, are sole agents for Great Britain.

BOOKS RECEIVED.

The Structure of the Brain. By Albert Wilson, M.D. (Elliot Stock.) Illustrated.

Experimental Physics. By Eugene Lommel. Translated from the German, by G. W. Myers. (Kegan Paul.) Illustrated. 15s. net.

A System of Ethics. By Freidrich Paulsen. Edited and translated by Frank Thilly. (Kegan Paul.) 18s. net.

The Reliquary and Illustrated Archæologist, 1899. Edited by J. Romilly Allen, F.S.A. (Bemrose.) 12s net.

Newton's Laws of Motion. By P. G. Tait, M.A. (Black.) 1s. 6d. net.

Practical Physiology. By M. Foster and J. N. Langley. (Macmillan.) Illustrated. 7s. 6d.

Art-Enamelling on Metals. By Henry Cunnyghame. (Constable.) Plates. 6s. net.

Liquefaction of Gases. By Willett L. Hardin. (Macmillan.) Illustrated. 6s.

Chemistry for Organized Science Schools. By S. Parrish and D. Forsyth. (Macmillan.) Illustrated. 2s. 6d.

Report and Transactions of the South-Eastern Union of Scientific Societies, 1899. (Taylor & Francis.) 2s.

The Teaching of Geography in Switzerland and North Italy. By J. B. Reynolds, B.A. (Camb. Univ. Press.) Illustrated. 2s. 6d.

Human Nature. Part II. By Physicist. (Churchill.) 2s. 6d.

Sylvia in Flowerland. By Linda Gardiner. (Seeley.) Illustrated. 3s. 6d.

The Standard Intermediate-School Dictionary. By James C. Fernald. (Funk and Wagnalls Co.) 4s.

Schilling's Spanish Grammar. Translated by F. Zagel. (Francis Hodgson.)

Introduction to Physical Chemistry. By James Walker. (Macmillan.) 10s. net.

Catalogue of Optical and Scientific Instruments, and Lantern Slides. (Newton & Co.) 6d.

Egyptian Magic. By E. Wallis Budge. (Kegan Paul.) Illustrated. 3s. 6d.

Star-Land. New Edition. By Sir Robert Ball. (Cassell.) 7s. 6d.

Mr. Blackburne's Games at Chess. By P. Anderson Graham. (Longmans.) 7s. 6d. net.

The Student's Standard Dictionary. (Funk and Wagnalls Co.) Illustrated. 10s. 6d.

The Strength of Materials. By J. A. Ewing, F.R.S. (Camb. Univ. Press.) 12s.

Classified Catalogue of New Film Subjects. (Warwick Trading Co.)

Crystallography. By W. J. Lewis, M.A. (Camb. Univ. Press.) Illustrated. 14s. net.

The Wonders of Modern Mechanism. Third Edition. By Chas. H. Cochrane. (Lippincott.) Illustrated. 6s.

Handbuch der Astronomischen Instrumentenkunde. By Dr. L. Ambronn. Two vols. (Berlin: Julius Springer.)

Designing and Drawing for Beginners. By Charles Godfrey Leland, M.A. (Dawbarn & Ward.) 6d.

The Studio. November. 1s.

THE KARKINOKOSM, OR WORLD OF CRUSTACEA.—XII.

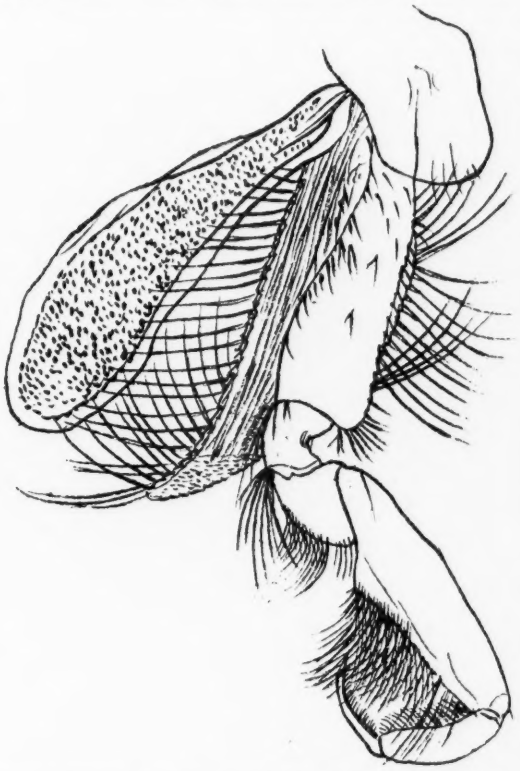
By the Rev. THOMAS R. R. STEBBING, M.A., F.R.S., F.L.S., F.Z.S., *Author of "A History of Crustacea," "The Naturalist of Cumbrae," "Report on the Amphipoda collected by H.M.S. 'Challenger,'" etc.*

A BREATH OF WATER.

"ONE must live," said the tramp. "No," replied the cynical alderman, "I don't see the necessity." But, at all events, in order to live, one must breathe. This is indispensable alike to tramps and aldermen and crabs, and to every item of the animal world. Some minute organisms may be desiccated by heat or frozen by liquid air into a state of suspended animation, and a stuffed lion in a museum, or an embalmed Pharaoh in a pyramid, may out of courtesy still be called an animal, though each ceased to be one as soon as the breath was out of its body. Breath being so essential, respiration, like perspiration, all over the surface, wears the aspect of an advantage. It is, in fact, not to be despised, and, such as it is, this advantage is enjoyed by several animals, and among them by some of the crustacea. But with increasing complications of structure and existence, more than one consideration comes into play, as the greedy boy, who wished that he was all mouth, would speedily have discovered. Nature, in her more elaborate efforts, utilizes division of labour, and allots special organs to special functions. Anyone who has used a hammer for cracking open the claw of a crab, will understand how unsuitable a surface for respiration would be afforded by that stony water-tight integument.

In bringing to perfection her wonderful karkinokosm, Nature certainly did not begin by making crabs, but rather in that line of business produced them as the crown of her operations. To follow Nature, then, we must not begin by investigating the breathing apparatus of a crab, but follow down the line till we come to something simpler. Pause, then, at the amphipods. Specimens can be had without cost. Certain species have been already portrayed in earlier chapters (III., IX., XI.). An amphipod might be familiarly described as a lobster in a short jacket. It differs from the lobster in that its eyes are not movable on jointed stalks. With its whole body so small and nimble, separate ocular mobility could scarcely be needful to it. Otherwise, in the general inventory of its kit, this little campaigner agrees with the lordly lobster, thus:—Antennæ, two pairs; one upper lip, one lower; one pair of mandibles; maxillæ, two pairs; maxillipeds, three pairs; and five pairs of trunk legs. By all means catch a *Gammarus pulex* in the rivulet that runs through your park, or a *Gammarus locusta* that slidders under weeds and stones on almost any sea-shore, to see whether I have counted right. In doing this you cannot fail to observe that in the *Gammarus*

the first of the five pairs of trunk-limbs are feeble walking legs, whereas in the lobster they carry the well-known



Second gnathopod of Amphipod, *Pardalisca abyssi* Boeck, with the branchia and marsupial plate.

powerful claws. Also you will find that the second and third maxillipeds are not here consolidated at their bases with the other jaws, and that they have exchanged their Latin name for a Greek one, gnathopods, which means exactly the same thing, only it sounds better, more oracular and Demosthenic.

Not only in name and function, however, do these gnathopods of the Amphipoda differ from the homologous maxillipeds of the lobsters, crabs, and shrimps. In all the latter groups, speaking generally, it will be found that the animal's coat, or carapace, covers the segments belonging to all the mouth-organs, and to all the trunk-limbs. On the contrary, in the amphipod it is a mere jacket. It stops short at the segment bearing the first maxillipeds, leaving exposed the segments that carry the two pairs of gnathopods and the five pairs of walking-legs. This is a very essential difference, and implies that the Amphipoda are at a much more primitive stage of development than those crustaceans which have gathered their segments more closely under shelter, and devoted more of their limbs to the service of the mouth.

High up on the second gnathopods, and some or all of the following limbs of an amphipod, there will be found attached semi-pellucid vesicles, a kind of small bags, sometimes flattened, sometimes dilated, sometimes crumpled or twisted, sometimes with other modifications. These are the breathing organs. They hang freely in the water. They are sometimes reduced to a couple of rod-like pairs; but whether more or fewer, they are no doubt nicely adapted to the owner's requirements. When a living amphipod in water is viewed under the microscope, at more or less transparent parts of its skin a number of little globules can be seen, chasing one another merrily about its body. It is, or should be, the ambition of each of these little colourless globules to traverse sooner or later one or other of the branchial vesicles. In such a passage, whether in circuit or struggling through the labyrinth of transverse canals, it will gather from the outside water a new supply of oxygen. Then it will pass into a chamber surrounding the heart, called the pericardium. There it will craftily bide its time. Presently the little side-doors of the heart are opened, and it will pass through with its companions into the august sanctum, thence in turn to be sent forth, through one of the aortic portals, on a fresh career of usefulness. Harvey discovered the circulation of the blood; he didn't invent it.

With the branchial sacs of the Amphipoda it looks as if Nature had been trying a series of experiments, first using a small, simple form, then enlarging the surface, puffing it out, adding a fold or two, and finally pleating the whole into a row of leaflets. The object aimed at is to expose as large a permeable surface as possible for procuring oxygen from the external water. In the higher crustaceans, the experimentation conducted on the bodies of the lower bears its fruit. It becomes no longer a question of simple branchial sacs. The forms are described as arborescent, leafy, or hairy—dendrobranchiate, phyllobranchiate, trichobranchiate. Each branchia is divided up into an immense number of compressed and closely adpressed leaflets, or still more finely sub-divided so that the filaments are comparable to hairs, or there may be a mixture of the two, or a kind of cross between them, with hair-like fringes to a leaf-like base. These more elaborate organs are worth a little extra care, and in the Brachyura and Macrura they are all neatly arranged out of sight under the carapace. For them, however, "Out of sight,

Branchial Plume, seen in section, of Deep-sea Prawn, *Plesiopenæus armatus* Bate. From Bate.

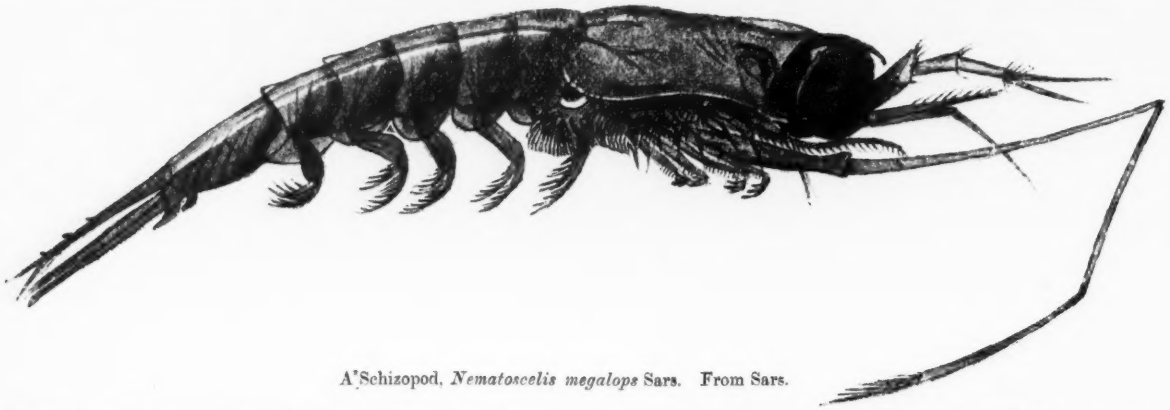
out of mind," would be a very inapplicable motto. Careful order is taken, so that by appropriate orifices water may

flow in upon these sheltered branchiæ, and may, when it has served its turn, by other orifices flow out again. In this business, the second maxillæ are adapted to play a highly important part, supplying a sort of lock-gates or valves, which, in rhythmic beats, regulate the inflow and efflux of the respiratory stream. Here, too, as elsewhere in nature and art, circumstances alter cases. Thus, Mr. Walter Garstang has shown that the Masked Crab (*Corystes cassivelaunus*), when buried in the sand under water, reverses the usual current. This is almost a necessity of its situation. The water-pipe which connects it with its reservoir, the superincumbent ocean, is formed by its long setose antennæ. By utilizing this for the intake instead of as a discharge pipe, the crab obtains good water from above and allows the used-up supply to filter away into the absorbent sand around it. Various crabs have made experiments in the art and mystery of an open-air life. You do not, perhaps, realize the heroism of such an adventure to creatures formed for aquatic respiration. It is something like our sailing in a balloon over Mount Everest. A little economy of resources becomes expedient. To this end some of the little sea-quitting crabs show a pretty adaptation. Instead of having the carapace smooth on its under surface, they have it minutely furrowed and cross-furrowed. Fritz Müller explained the reason of this ornamentation. The crab, on leaving the water, can take a supply of that element with it in its branchial chamber—a supply, but a strictly limited supply. After expelling this through the efferent orifices at the sides of the mouth, the crab, in the ordinary condition of things, would begin to gasp for want of a breath of water. But the little crabs in question can let the exhaling stream trickle through the network of their stomacher, or waistcoat, as one might call it, and it will take up oxygen from the outside air and be fit for breathing over again in the branchial chamber.

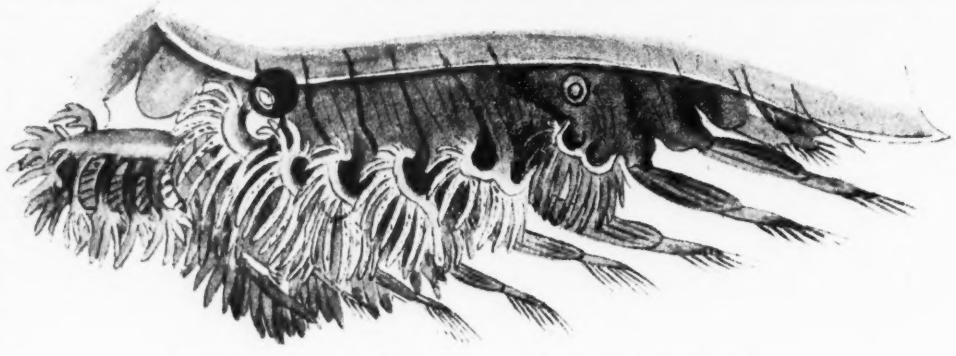
It is, perhaps, in the deep-sea prawns that the branchial plumes, as they are called, attain their highest elaboration and beauty. The explanation is that in the great depths the supply of oxygen is very scanty, and therefore greater and greater sub-division of the branchiæ becomes desirable for increasing the absorbent surface.

Very striking also are the branchial organs in the Schizopoda, and these animals are not at all chary of displaying them. The sides of the carapace are not jealously folded round but coquettishly raised, as though the creature were saying to itself, "It is a pity you should not see my graceful curls." It is just such a contrast as we find in the harbours of the world, some of which are suspiciously guarded against inspection, while others invite and demand the admiring gaze of every fresh beholder.

All the crustacea above mentioned, with one or two peculiar groups to boot, may be said to form a series strictly interconnected in respect to their respiratory system. But important divisions of the Malacostraca remain, which breathe, not indeed in an entirely different way, but with an entirely different part of the body. Hitherto we have been exclusively concerned with the head and trunk of the animal, leaving the tail to take care of itself. There is sometimes a difficulty in persuading people that a crab has a tail, because the fashion among crabs is to wear it so very thin and small, and to tuck it underneath with a sort of deprecatory air, as if to say, "Oh, no, we never mention it in our family, leastways, not out of the family." In lobsters, on the other hand, and prawns, and a great host of crustaceans which have no English names, the tail is muscular and powerful, and might often be called the predominant partner. Still, it does not carry the breathing organs. But when we turn to the rapacious Squillidæ, we find a new development.



A Schizopod, *Nematoscelis megalops* Sars. From Sars.



Branchiæ of *Nematoscelis megalops*, more highly magnified. From Sars.

Here the tail is massive and muscular as in any lobster or crawfish. But it is something more. It is the home of the respiration. On its swimming-legs, filamentous branchiæ are developed, adding one more singularity to the many which distinguish the appearance and character of this strange set of animals.

In having a caudal system of respiration, the Squillidæ are companions of a widely different, and far more extensive and varied division, the Isopoda. These are dispersed over all oceans. They track the footsteps of mankind in every land, or scale the mountains and explore the wilderness in advance. To them the common woodlouse belongs, and many an uncommon woodlouse. By their sessile eyes, and their short jackets, and often by the general aspect of their legs, they seem to be akin to the Amphipoda, and with them they have another link of connexion in the simplicity of their breathing organs. Nevertheless, those organs in the Isopoda, instead of belonging to the legs of the trunk, belong to the pleopods, or legs of the tail.

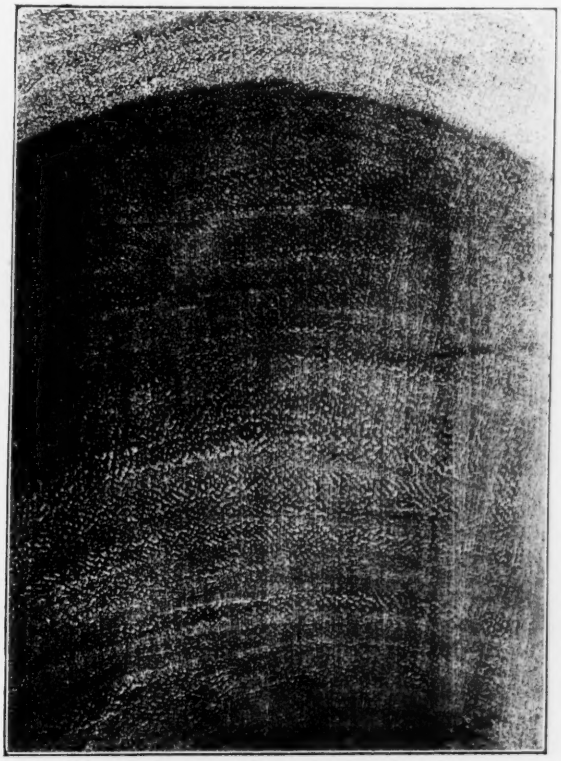
By name and nature, size and shape, a woodlouse makes little appeal to our romantic feelings. It may claim respect for antiquity of lineage. In some species it shows a willingness to march with the times, by adapting its branchiæ to a sort of tracheate respiration, such as suits a subaerial, as distinct from an aquatic existence. But by extraordinary variety of form and structure, its oceanic cousins, the Isopoda in general, afford a study of remarkable interest. They are seldom, it is true, very large, condescending sometimes to the twentieth of an inch, though ranging at others up to three or four inches of length by an inch of breadth. Till about twenty years ago, these were the monsters of the isopod order. But then, to the astonishment of carcinologists, there was hauled up from a depth of about one thousand fathoms, *Bathynomus giganteus*, four inches broad and more than nine inches long. It is a true isopod, with nearly four thousand facets in each of its great sessile eyes, and with the normal appendages according to rule. Only in one point it is exceptional. To assist the breathing in this great deep-ranging carcase, arborescent branchial appendages have grown out from the laminæ of its pleopods, parallel after a fashion to what has been described in the Squillidæ. So, in various ways, does Nature provide for the welfare of all her children. So thinking, Linnæus prefixed to his Systema, the saying, "O Jehova, quam ampla sunt Tua opera! quam sapienter ea fecisti! quam plena est terra possessione Tua!"

Microscopy.

By JOHN H. COOKE, F.L.S., F.G.S.

To the current issue of the *Transactions of the Botanical Society of Edinburgh*, Mr. R. A. Robertson contributes a practical paper on the "Photomicrography of Opaque Stem Sections—Recent and Fossil." Mr. Robertson's method has much to recommend it to all who are engaged in research work or teaching, and who need a method of reproducing accurately the diagnostic characters of timber as seen in transverse and longitudinal sections. Micro-sections as usually made do not present enough surface to exhibit, typically, all of the characteristic appearances. Large areas are therefore necessary, and it is to a demonstration of the best method of obtaining these that this paper is devoted. No sectioning is necessary, as only the specially dressed opaque surface of the block of wood is micrographed. This is a distinct advantage where museum specimens are concerned, as the micrograph may be taken without in any way damaging the preparation.

A photo-micrographic camera, which is capable of working either vertically or horizontally, is best adapted for the purpose. The microscope accessories are removed and a half-plate lens is fixed to the front of the camera. The wood specimen is propped up in position in front of the camera so that the plane surface is at right angle to the optic axis of the apparatus. Focussing is arranged by means of a Welsbach incandescent gas light, which stands on one side of the apparatus, and finally by means of a focussing glass and magnesium wire. The radiant for exposure is a magnesium ribbon apparatus, arranged like the Welsbach on the opposite side. Mr. Robertson's experiments show that eight inches from the surface of the wood is the best position for the light when exposing. The time of exposure varies with the plate, intensity of light, and colour of the wood. With slow Ilfords forty seconds has been found to give very satisfactory results. The accompanying micro-photograph of a transverse section of a stem of *Acacia catechu* was taken by this method by Mr. Robertson.



Micro-Photograph of *Acacia catechu* (transverse section).

For obtaining photo-micrographs of smaller areas of surface under a somewhat higher magnifying power, a microscope is used with a low-power objective in place of the photographic lens. A lens fitted with an iris diaphragm, on the same principle as a photographic lens, is the best adapted for the purpose. The ocular is removed, and a tube of mat-black paper is substituted. The microscope is then bent over into a horizontal position, and connected with the camera. Illumination, focussing, and exposure are the same as before, but greater care, if possible, is required.

The practical value of a knowledge of common crystals, and of the modifications that they undergo when subjected to various modes of treatment, has been frequently brought home to the chemist and mineralogist when engaged on the determination of unknown substances. No microscopist can consider himself fully equipped for his work who has not made himself familiar with the commoner kinds of crystals prepared from alcoholic and aqueous solutions, saturated and dilute; by spontaneous drying and crystallization; and by rapid crystallization with the aid of heat. It was whilst pursuing the study of this branch of microscopical research that Dr. Sorby made some of his most startling discoveries. One of these was the determination of the nature of the liquid which fills the

minute cavities, either wholly or in part, of many gems and crystals. A fine sapphire in his collection contained a cavity of a tubular form. This cavity was so regular in its bore that it served the purpose of a natural thermometer. It was a truly microscopical instrument, measuring only one-fourth of an inch in length, and about one-eighteenth of an inch in diameter. On experimenting with this gem it was found that the liquid which half filled the cavity at fifty degrees Fahrenheit, expanded so rapidly that its volume was doubled at eighty-nine degrees Fahrenheit. This increase of bulk within such narrow limits of temperature excluded all ordinary liquids, and on further investigation, Dr. Sorby decided that the liquid was nothing less than liquid carbonic acid.

Problems connected with the tillage of the soil have, hitherto, been looked upon as belonging to the domain of the physicist and chemist. It is only quite recently that it has come to be recognized that the soil teems with myriad minute forms of life—useful, harmful, and neutral, and that therefore it is necessary to look for a solution of the problems not to the chemist and physicist alone, but also to the biologist. Soil bacteriology has been engaging the attention of Mr. R. Stewart MacDougall, and in a communication to the Botanical Society of Edinburgh, he briefly summarized the methods that are employed for a microscopic examination of the bacteria contained in a sample of any given soil. One gramme of the earth is weighed, placed in a quart of sterilized water, and thoroughly mixed with it by shaking. A glass tube, containing gelatine which has been rendered germ free by repeated heating in a steam bath, is prepared; and the gelatine, when liquefied by a gentle heat, has added to it by means of a sterilized pipette 1 c.cm. of the mixture of water and earth. After a thorough mixing, the entire contents are poured out of the tube on to a gelatine plate. In a short time the bacteria begin to grow and multiply by fission, and soon each gives rise to a colony. To get a pure cultivation of a particular species, a small part of a colony is removed with a platinum needle, and is introduced into a fresh gelatine tube.

NOTES ON COMETS AND METEORS.

By W. F. DENNING, F.R.A.S.

GIACOBINI'S COMET (discovered September 29th) passed its perihelion at the middle of September, and is now receding from both the sun and the earth. At present, the position of the comet is unfavourable, being low in the western sky after sunset, and the object itself being faint, it will be practically invisible in December even in the largest telescopes. At the beginning of that month the distance of the comet from the earth will be no less than two hundred and fifty millions of miles.

HOLMES'S COMET has been exceedingly faint at its recent return, and will soon pass altogether out of reach. It appears to have been very little observed, and it is very fortunate that Messrs. Perrine and Aiken secured a series of observations between June 10th and September 9th. These were obtained with the 36-inch refractor, and are the only ones published, so that it is fair to conclude that some of the other large telescopes failed to show the comet.

PERIODICAL COMETS.—In 1900 the return of several of these interesting bodies will be due. Finlay's comet ought to arrive at perihelion at the end of February, while De Vico-Swift's comet (1844 I. and 1894 II.) is expected in August. Barnard's comet (1884 II.) is due in September.

FIREBALL OF SEPTEMBER 2ND, 12H. 4½M.—A meteor much brighter than Venus was seen at this time by the writer at Bristol, and by Mr. Ivor F. H. C. Gregg at Great Malvern. It left a streak for one minute. At Bristol the path was recorded as from 40°+67° to 37°+74°, while at Great Malvern it was from 15°+45° to 345°+40°. A comparison of the two observations shows that the radiant was at 46°+42°, so that the meteor belonged to the α-β Perseids ("General Catalogue of Radiants," XLIII.). The height of the object at its first appearance was eighty-six miles over Shipston, and at its disappearance sixty miles over Tewkesbury. Its earth point was at Aberdare, and its observed length of path twenty-eight miles. The meteoric stream from which it was derived has been previously observed as follows:—

1887, August	30	...	46°+43° W. F. D.
,, September	1–13	...	45°+40° Heis.
1870 ,,	5	...	48°+41° Tupman.

It sometimes furnishes brilliant fireballs. One of the meteors which I recorded from it in 1887, August 30th, was equal to Venus. It appeared at 14h. 27m., and traversed a path of 18½° from 19°+27° to 5°+14°.

FIREBALL OF OCTOBER 2ND, 8H. 20M.—This fine object, referred to in last month's Notes, was also seen by Mr. W. S. Price, at Wellington, Somerset. He says it moved with exceptional slowness, even for a meteor travelling from W. to E. Its apparent brightness was scarcely equal to that of Jupiter at opposition, and it exhibited a deep yellow colour. Towards the end of its path it divided into four distinct fragments, all of which moved in the same line.

FIREBALL OF OCTOBER 8TH, 6H.—A splendid meteor was reported as seen at Epsom, West Norwood, Hayward's Heath, and other places. It passed from S.W. across the zenith to N.E., and its duration of flight was variously estimated as eight, ten, and ten to twelve seconds. Its colour was a glistening primrose yellow, and it left a momentary trail. At Epsom, Mr. W. Nash says he was fortunate in seeing the meteor from the start to the finish, and that it travelled from one horizon to the opposite one. The object was a very interesting one, being evidently derived from a radiant in Scorpio or Libra near the horizon. It must have passed over the English Channel and South of England, but the descriptions already to hand are not sufficiently definite to enable exact calculations to be made as to its real path in the air.

THE SHOWER OF LEONIDS IN 1899.

The expected display has come and gone, and it seems very probable, from the descriptions already to hand, that the meteors have again disappointed expectation. But the weather is in a measure responsible for this, for at many places the nights following November 14th and 15th were densely overcast. At some stations, however, the sky was partly clear, and a few Leonids were seen in the moonlight, but only in very moderate numbers. A brilliant display, such as that of 1799, 1833 or 1866 was entirely wanting. The following is a summary of some of the reports received:—

November 10th, 13h. to 15h. 30m., 19 meteors mapped, but no Leonids.—A. S. Herschel.

November 10th, 11h. 25m. to 14h., 13 meteors mapped, but no Leonids.—W. E. Besley.

November 10th, 12h. 40m. to 14h. 40m., 13 meteors mapped, but no Leonids.—W. F. D.

November 10th, 26 meteors but no Leonids.—T. H. Astbury.

November 11th, 14h. 30m. to 16h. 30m., 10 meteors seen, including 2 Leonids.—W. F. D.

November 12th appears to have been overcast nearly everywhere. At Slough, 17h. 30m. to 18h., Prof. Herschel observed 2 meteors, one of them a Leonid.

November 13th, 17h. 15m. to 18h., 5 meteors seen, including one Leonid. Sky only one-fifth clear.—W. F. D.

November 14th, 50 Leonids seen in three hours.—Oxford University Observatory.

November 14th, 10h. 30m. to 18h., 98 meteors (66 Leonids) seen, including a splendid non-Leonid, at 17h. 40m., leaving a train visible for five minutes.—Sir W. J. Herschel.

November 14th, 13h. 30m. to 14h. 15m., one Leonid seen.—A. S. Herschel.

November 14th, 14h. 30m. to 18h., 28 meteors seen, including about 24 Leonids.—R. I. Ryle.

November 14th, 16h. 3m. to 17h. 53m., 25 Leonids registered, and about a dozen others seen. There was a considerable amount of fog.—T. H. Astbury.

November 15th, 20 meteors seen during the whole night, including 15 Leonids.—Robert Service.

Reports for the night of Nov. 16th either speak of the overcast state of the firmament or announce that comparatively few meteors were seen.

A telegram from New York states that the observers at Vanderbilt University were rewarded with a brilliant meteoric display on the night of Nov. 14th. Meteors passed at intervals of

a minute or two, and radiated from the constellation Leo. At Brown University fifty-five Leonids were counted.

On the whole the shower seems to have been decidedly poor, and goes far to prove that the earth has not yet encountered the really dense section of the cometary meteor-stream. It will be remembered that there were fine displays in each of the years 1866, 1867, and 1868. The next two years 1900 and 1901 may well be expected to witness their recurrence. But the parent comet of the meteors (Tempel I., 1866) passed through its perihelion last spring, and the earth must have recently travelled through a part of the orbit much nearer the comet than the sections it will encounter in the next two years.

THE FACE OF THE SKY FOR DECEMBER.

By A. FOWLER, F.R.A.S.

THE SUN.—On the **1st** the Sun rises at 7.44, and sets at 3.54; on the **31st** he rises at 8.8 and sets at 3.58. Winter commences at 1 A.M. on the **22nd**, when the Sun enters Capricornus. There will be an annular eclipse of the Sun on the **2-3rd**, invisible at Greenwich; the annular phase will only be visible in the Antarctic regions, but a small partial eclipse will be seen in New Zealand, Tasmania, and South-western Australia.

THE MOON.—The Moon will be new on the **3rd**, at 12.48 A.M.; will enter first quarter at 9.3 P.M. on the **9th**; will be full at 1.31 A.M. on the **17th**; and will enter last quarter at 3.57 A.M. on the **25th**.

There are no striking occultations at convenient hours during the month, but it may be mentioned that Neptune will be occulted on the morning of the **17th**; disappearance at 3.36 A.M., at 150° from the north point (118° from the vertex); reappearance at 4.11 A.M., at 222° from the north point (180° from the vertex).

There will be a partial eclipse of the Moon commencing just before midnight on the **16th**. The magnitude of the eclipse is 0·995, so that it is very nearly total. The contacts are as follow, Greenwich mean time:—

First contact with penumbra,	Dec. 16th,	10h. 33·7m. P.M.
,, ,, shadow	,,	11h. 44·6m. ,,
Middle of Eclipse ...	Dec. 17th,	1h. 25·9m. A.M.
Last contact with shadow	,,	3h. 7·2m. ,,
,, ,, penumbra	,,	4h. 18·1m. ,,

The first contact with the shadow occurs at 66° from the north point of the Moon's limb towards the east, the last 59° towards the west; in each case for direct image.

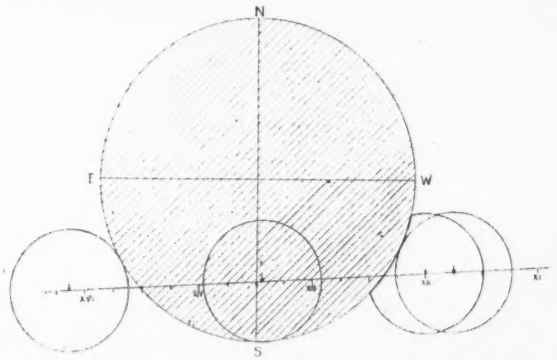


Diagram showing the Moon's path through the Earth's shadow, Dec. 16-17th, and the phase of eclipse at midnight.

The path of the Moon through the shadow of the Earth is illustrated in the accompanying diagram, in which the scale indicates the position of the Moon's centre at corresponding times.

THE PLANETS.—Mercury is in inferior conjunction on the morning of the **6th**, and is afterwards a morning star, reaching greatest western elongation of 22° 5′ on the **25th**. On account of his southerly declination, however, he will not be well placed for observation in our latitudes.

Venus is an evening star, but is still badly placed for observation.

Mars, Jupiter, Saturn, and Uranus may all be considered unobservable.

Neptune is in opposition on the **17th**, and during the month describes an arc nearly a degree in length, with a westerly motion. His path lies almost midway between ζ Tauri and η Geminorum.

THE STARS.—About 9 P.M. at the middle of the month, Cancer, Gemini, and Canis Minor will be towards the east; Auriga high up towards the east; Taurus and Orion towards the south-east; Perseus and Cassiopeia nearly overhead; Aries and the head of Cetus on the meridian; Andromeda high up towards the north-west; Pegasus a little south of west; Cygnus and Lyra towards the north-west; and Ursa Major a little east of north.

Convenient minima of Agol occur on the **12th** at 9.3 P.M. and on the **15th** at 5.52 P.M.

Chess Column.

By C. D. LOCOCK, B.A.

Communications for this column should be addressed to C. D. LOCOCK, Netherfield, Camberley, and be posted by the 10th of each month.

Solutions of November Problems.

(J. K. Macmeikan.)

No. 1.

1. P to K4, and mates next move.

No. 2.

1. R to B7, and mates next move.

[There is an unfortunate dual after 1. . . . K to B3.]

CORRECT SOLUTIONS of both problems received from E. Servante, Alpha, W. de P. Crousaz, H. S. Brandreth, G. C. (Teddington), J. Baddeley, Captain G. A. Forde, K. W., H. Le Jeune, F. B. L. (Devonport), Rev. H. J. Riddelsdale, Gerald F. Todd, J. E. Lelliott, W. d'A. Barnard, J. Neville.

G. F. Todd.—If you would send the key you gave, we shall be glad to point out Black's defence. We fancy it was Kt to Kt5, or a move with the Bishop.

J. T. Blakemore.—Too late to acknowledge last month. You will have seen that your second attempt at the four-mover was quite correct. It seems that ten only, out of the thirty regular solvers of the "B. C. M." problems, proved equal to this very difficult production.

E. Servante.—The game enclosed shows that you are cultivating a brilliant style, but your opponent's play is too weak to enable any correct idea of your strength to be formed. At move 16 it would have been prettier to mate with the Bishop instead of the Queen.

J. Baddeley.—Certainly it is better to solve from the diagram if possible. In the case of two-movers there is no excuse for not doing so, and the same may apply to fairly simple positions in three or four moves, especially those in which the Black King is confined. It is doubtful, however, whether the majority of solvers can really appreciate the beauties of a complicated three-mover or four-mover without setting up the position and moving the pieces, but, of course, the problem *may* previously be solved from the diagram alone.

Gustav v. Broecker.—Many thanks for the programme.

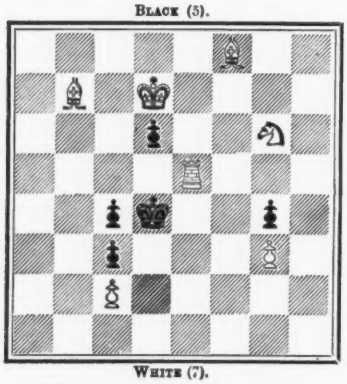
XUM

PROBLEMS.

By C. D. Locock.

No. 1.

BLACK (5).

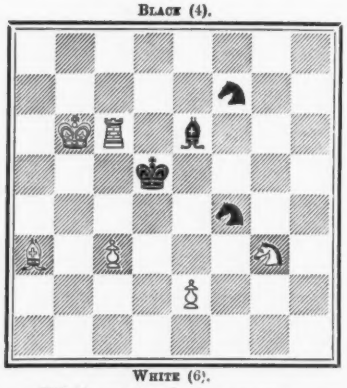


WHITE (7).

White mates in two moves.

No. 2.

BLACK (4).



WHITE (6).

White mates in two moves.

[The publication of Editorial compositions signifies, as usual, that the stock of problems sent in by the solvers of KNOWLEDGE has once more become exhausted. Can the deficiency be supplied ?]

CHESS INTELLIGENCE.

Messrs. J. L. Cope and J. W. Russell, joint hon. secretaries of the recent London Tourney, inform us that "the gold medal presented by the Ladies Chess Club for the winner of the most brilliant game in the recent Masters' Tournament, has been awarded to Mr. Lasker for his game against Mr. Steinitz in the second round. The prize of Ten Guineas presented by Mrs. F. H. Lewis and Mr. Harry Lewis for special brilliancy in any game played in the recent Masters' Tournament, has been awarded to Mr. J. H. Blackburne for his game against Mr. Lasker in the first round."

The Janowski-Lasker match appears to have fallen through, owing to failure in agreement as to the number of games to be played. M. Janowski may perhaps play a match with Mr. Showalter. Failing that, Messrs. Steinitz and Showalter will play a "series" of games.

The International Tournament next year will take place, as might have been expected, at Paris. It will be a one-round contest, limited to twenty-four players.

The appended game was played in the recent London Tournament :—

"Ruy Lopez."

WHITE (D. Janowski).	BLACK (M. Tchigorin).
1. P to K4	1. P to K4
2. Kt to KB3	2. Kt to QB3
3. B to QKt5	3. Kt to B3
4. Castles.	4. B to K2
5. Kt to B3	5. P to Q3
6. P to Q4	6. Kt to Q2
7. Kt to K2	7. Kt × P
8. Kt × Kt	8. P × Kt
9. Kt × P	9. Castles
10. Kt to B5	10. B to B3
11. P to QB3	11. Kt to B4
12. Kt to Kt3	12. B to R5
13. P to B3	13. B × Kt
14. P × B	14. B to Q2
15. B to K2	15. Q to K2
16. P to KKt4	16. KR to Ksq
17. R to B2	17. QR to Qsq
18. B to K3	18. B to B3
19. P to QB4	19. P to QR4
20. Q to B2	20. Q to R5
21. Q to Q2	21. P to B3
22. Q × RP	22. P to R4
23. P × P	23. R to K4
24. P to KKt3	24. Q × Pch
25. R to Kt2	25. Q to R6
26. Q × P	26. Kt to K3
27. R × Pch	27. Kt × R
28. Q × Rch	28. Kt to Ksq
29. B to B4	29. R × P
30. K to B2	30. Q to R5ch
31. K to K3	31. K to B2
32. R to KKtsq	32. R to Rsq
33. P to B5	33. Resigns.

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